Sida Evaluation 97/34

Swedish Support to the Energy Sector in Eritrea

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Department for Infrastructure
and Economic Cooperation

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EXECUTIVE SUMMARY

Introduction

Eritrea's 30 year war for independence left an utterly devastated infrastructure. Over-utilisation of traditional fuels (wood and biomass) almost eliminated the vegetative and forest covers. The electricity system was in disrepair and the lack of electricity supply was severely limiting industrial and commercial production. Eritrea Electric Authority, EEA was created in 1991 and had to jump-start as an independent supply authority. The top management, albeit dedicated, consisted of veterans from the war and out of touch with modern technology and management practices.

The Swedish support to the energy sector in Eritrea started in 1992 through a cooperation arrangement between EEA and Sydkraft. It included support for increased electricity production, management development and the elaboration of master plans for long-term securing of electricity supply. The support from 1992 to 1995 has amounted to SEK 28 million from emergency funds.

In 1996, Sida commissioned a three-pronged study to analyse the results of the support, to review the sector and to screen possible areas for future support. Ralph Kårhammar (ARKTECH AB) carried out the study, based on document review, a visit to Eritrea and interviews.

Analysis of Swedish Support

The Swedish support increased the *electricity generation capacity* with 7 MW, i.e. 40% from the peak load of 17 MW during 1992. The support improved the *technical capacity* and the *administrative efficiency* of EEA. The number of staff was reduced by 20% and the proportion with higher qualifications and better training increased. The reliability of the generating stations and the line networks increased and thus provided for a *more reliable power supply* in the country. The *Master Plans and Feasibility Studies* allowed EEA to seek and obtain international financing for a huge $127 million expansion of the power generation capacity and the transmission grid.

The World Bank estimated that the shortage of electric power by Independence reduced the potential Gross Domestic Product by 30-50%. The Swedish assistance was therefore very timely and relevant.

The support on the whole met the stipulated objectives. However, the management development did not provide all the planned results. The services specified in Sydkraft's contract were too ambitious given the available time and the number of visits. In a couple of cases planned work was included in contracts under other financing, e.g. the tariff and accountancy studies. The flexible cooperation procedures allowed EEA and Sydkraft to re-schedule components in the support, while keeping costs within the budget.

The increased generation capacity enabled increased energy sales of some 23 200 MWh/year, which corresponds to Birr 20 million in sales. The extra 7 MW generating capacity resulted in a socio-economic benefit to Eritrea of at least $10 million/year.

Sector Analysis

Traditional fuels (wood and biomass) account for over 80% of Eritrea's energy consumption and the rest comes from oil products. This has resulted in fast deforestation of the shrubs and tree cover and consequent alarming degradation of the environment. The forest cover in Eritrea has gone down from about 15% of the land surface in the 1940's to about 0.4%. Electricity, all generated from oil, represents about 1.2% of the energy consumption.

There is some potential for *hydropower* exploration, but as the rivers are not perennial the resulting electricity would be expensive. High radiation levels make *solar energy* a promising source of energy, but the current contribution is negligible. There are indications of *oil and natural gas* reserves within Eritrean territory and the Government has signed a prospecting contract with a US-based oil company. Prospects of *geothermal* energy are also promising. The Assab and Tessenei areas have viable *wind* velocities for electrical generation.

Eritrea has two electrical systems supplied with thermal electricity generation. *The Inter Connected System (ICS)* supplies the city of Asmara, the Port of Massawa and several other small towns along a 50 kV transmission line between Asmara and Massawa. *The Self - Contained System (SCS)* consists of ten isolated supply centres, including the major towns of Assab, Dekemhare, Keren and Mendefera. The capital Asmara (400 000 inhabitants) consumes about 2/3 of the available electrical energy and Massawa and Assab (40 000 and 50 000 inhabitants respectively) the remaining 1/3. The existing electricity shortage has become a major constraint to recovery and growth of Eritrea's destroyed economy.

EEA has the mandate to generate, distribute and sell electricity in Eritrea. The Government has indicated that it wishes to see EEA operating as a financially autonomous agency, with a tariff policy designed to recover all reasonable operating and capital costs. Assisted by a trebling of tariffs in December 1992, EEA has recovered from its previous weak financial position and has built up a modest capital reserve.

The recommendations in SWECOs 1994 Feasibility Study are being implemented. It includes to install an 84 MW Thermal Power Generating Station outside Massawa, to erect a 132 kV transmission line to Asmara and 66 kV lines to the ICS systems in Keren, Dekemhare and Mendefera. The existing 50 kV transmission line from Massawa to Ghinda will be rehabilitated and changed to 66 kV. The financing comes from the Saudi Fund, Kuwait Fund, Abu Dhabi Fund, BADEA, OPEC and Italy. There are plans to rehabilitate the outdated distribution systems in Asmara and Massawa (financing from the EU and Switzerland), to install a 132 kV substation in Ghinda and implement various rural electrification projects.

Recommendations

The LFA analysis lists activities to achieve the perceived immediate objective (adequate electricity supply). These include: staff training and institutional strengthening, transmission and distribution projects to achieve properly functioning equipment and systems, increased generating capacity, loss reduction and DSM measures, revised tariffs and billing systems. The proposed strategy for a continued Swedish support to the energy sector is to complement other financiers and donors in this endeavour and includes possible projects divided into three categories:

i) Concessionary financing for commercially viable investment projects:
1) 132 kV substation in Ghinda
2) Rehabilitation of parts of Asmara distribution network

ii) A mixture of grants and concessionary financing for projects with a social profile and which are not fully commercially viable:
3) Rehabilitation of Belesa, Gajjiret and Asmara Centre 66 kV Substations
4) Moving of a generator in Assab
5) Rural electrification

iii) Grant financing for "soft-ware" cooperation, i.e. studies, training, etc.
6) Institutional strengthening (Assistance with the regulatory framework, training, demand side management (DSM), loss reduction measures

7) Wind power studies
8) Energy Master Plan

RESULT ANALYSIS OF PREVIOUS SWEDISH SUPPORT TO THE ENERGY SECTOR, ERITREA

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ABBREVIATIONS AND ACRONYMS

BADEA	Arab Bank for Development in Africa
Birr	Legal tender in Eritrea and Ethiopia
DSM	Demand Side Management
ECU	European Currency Unit
EdM	Electricidade de Mocambique
EEA	Eritrea Electricity Authority
EELPA	Ethiopian Electric Light & Power Authority
Eskom	Electricity Supply Commission of South Africa
ESMAP	Joint UNDP/World Bank Energy Sector Management Assistance Program
EU	European Union
GDP	Gross domestic product
GWh	Gigawatthour= 1000 Mwh= 1 million kWh
IAS	International Accounting Standards
Kgoe	Kg of oil equivalent
kV	Kilovolt= 1,000 V
kW	Kilowatt= 1,000 Watt (W)
kWh	Kilowatthour= 1000 watthours (Wh)
LFA	Logic Framework Analysis
m	Meter(s)
MUSD	Million USD
MW	Megawatt, 1,000 kW= 1,000,000 Watt)
MWh	Megawatthour= 1000 kWh
NGO	Non Governmental Organisation
RRPE	Recovery&Rehabilitation Program for Eritrea
SEK	Swedish Kronor
Sfr	Swiss Franc
Sida	Swedish International Development Cooperation Agency
SSM	Supply Side Management
toe	ton of oil equivalent
UNDP	United Nations Development Program
US	United States
USD	US dollars
V	Volt

RESULT ANALYSIS OF PREVIOUS SWEDISH SUPPORT TO THE ENERGY SECTOR, ERITREA

1. INTRODUCTION

This report aims to analyse the results of the previous Swedish support to the energy sector in Eritrea, to give a brief out-line of the sector and to give recommendations for future support. The Terms of Reference for the assignment is attached as Appendix 1.

The report is based on material supplied by Sida, Eritrea Electricity Authority (EEA) and the Eritrean Department of Energy. Additional data and information was collected during a field visit by Ralph Kårhammar to Eritrea during 7 July to 23 July, 1996. During the period 13 July to 20 July Mr Per Persson, Head of Energy and Telecoms Division, Sida and Ms Annika Johansson, Task Manager Energy Projects, Sida Infrastructure and Economic Development Department also visited Eritrea.

The principal contacts are listed in Appendix 2 and the documentation reviewed is listed in Appendix 3.

2. ACKNOWLEDGEMENT

The Evaluation Consultant wishes to state that all information provided in this Report is his own interpretation of documentation and information gleaned during his work on this evaluation. It is always difficult to piece history together when interpreted from disjointed documents and fragmented information. By its very nature such an evaluation includes an amount of extrapolation, which may not entirely reflect the true history.

There are some comparisons in the Report with Mozambique and Zimbabwe. It does not imply that such comparisons are appropriate or significant, but merely that the Evaluation Consultant happened to have these figures readily available. However, it is hoped that such comparisons provide at least Sida with some reference points as Sida has been assisting those countries for some years.

A very warm thank you is extended to the staff of the Eritrea Electricity Authority, especially Mr Abraham and Mr Habtu for all assistance during this evaluation. It has been a most pleasant assignment.

3. ANALYSIS OF PREVIOUS SWEDISH SUPPORT

3.1 Background

The cooperation with Eritrea within the energy sector was initiated at the end of 1992. In the war torn country power supply installations had been severely damaged in several areas. The installations were old and run down, the operating costs high and the operational and maintenance knowledge limited.

A first project was financed with 8 MSEK from SIDA's emergency funds. It aimed at strengthening the receiving capacity within the electricity sector and was implemented through a "sister power company" cooperation between Sydkraft and Eritrea Electricity Authority. A precondition from the Swedish side for the support had been that it must be administered from Sweden as there was no Swedish representation in Eritrea. The main part of the support consisted of spare parts, which allowed installations to become operational again.

Considering the positive experiences from the initial cooperation SIDA was requested to prepare continued support during the fiscal year 1993/94. The preparations included visits from representatives from SIDA and EEA in respective countries. An agreement on cooperation was signed between SIDA and EEA. The agreement meant a continuation of the sister power company activities between Sydkraft and EEA. It also included a Feasibility Study by SWECO on an expansion of Eritrea's generation and transmission capacities.

The agreed amount for this second project was 20 MSEK from SIDA's emergency funds. The budget for equipment and spares was about 15 MSEK and 2.2 MSEK and 1.9 MSEK respectively for Sydkraft's and SWECO's contracts.

The second project was initiated at the beginning of 1994. The project could not be completed by 1994 06 30 and was extended to 1995 06 30. However, due to problems outside the contacts between SIDA and EEA, there was a desire to finish the project before that date. During November 1994 a plan for such finalisation was therefore handed to Sydkraft. No such plan was handed to SWECO as SWECO's assignment was practically completed by that time anyway.

3.2 Impact of Projects

The main objective of the support was to improve the effectiveness of the electrical supply in Eritrea by improved administrative efficiency of EEA and by increased electrical production capacity.

Administrative efficiency
Before Independence, when Eritrea was part of Ethiopian Electric Light & Power Authority (EELPA) and constituted Eritrea Region Electricity Supply Agency, it had more than 1000 employees. As a result of the restructuring exercise following Sydkraft's interventions 200 employees were retrenched. EEA is very proud of this achievement, i.e. to be the first organisation in Eritrea to understand, acknowledge and attack redundancy within its organisation.

EEA is grateful to Sydkraft for having successfully induced an understanding of efficiency and streamlining within the management. EEA highlights that one must recall the situation immediately after Independence. Due to the war Eritrea had been isolated from the modern office revolution and the demise of secretaries and messengers. At the time of Sydkraft's arrival in Eritrea there were some 20 messengers working at EEA's Head Office alone. The following table indicates a trend towards larger proportions of EEA staff at higher qualification levels.

Table 3.1: No. of Employees/Classification 1995 and 1996

Classification\Year	1995		1996	
	No's	%	No's	%
Professional Service	29	4	29	4
Sub-professional Service	243	31	238	30
Skill Works	251	32	312	39
Clerical Service	194	24	195	24
Custodian & manual	72	9	23	3
TOTAL	789	100	797	100

Electrical production capacity
As a direct result of the procurement of spares and materials the production capacity was increased with 7 MW.

Here again, EEA is accentuating the very difficult situation it faced after Independence. During the war and in particular the latter parts, fighting took place almost everywhere and curfew was upheld. The electrical production plants were given military order to be kept operating in spite of needing maintenance or overhauls. At Independence there was a huge backlog of maintenance and rehabilitation needs. Because Eritrea was a young and poor country many suppliers refused to deliver spare parts, because of perceived commercial or other risks. Initially it was only through Sydkraft that EEA could obtain spares. In addition this process was very fast because of the uncomplicated procurement procedures used. EEA was thus able to carry out vital maintenance and overhauls, which prevented the already operational production capacity from declining further.

Master Plans
The Master Plans and Feasibility Studies elaborated under the Project provide information about priorities and prudent production for a rational expansion of the generation and transmission systems. Beside providing guidance on different technical solutions, it has allowed Eritrea to seek international financing of investments. No doubt they benefited the recently acquired Middle East financing for a new generating station in Massawa and associated transmission lines to Asmara and other centres.

3.3 Relevance of Projects in Relation to overall Needs and Priorities

In its paper *Energy Situation in Eritrea and General Policy Guidelines* dated 8 January 1993, the Department of Energy indicates that EEA is responsible for electricity supplies to facilitate and not constrain the accelerated growth of Eritrea's economy.

The World Bank Country Economic Memorandum dated November 10, 1994, states "Eritrea currently suffers from chronic electricity shortages. The impact on the commercial and industrial sectors has been estimated to be as high as 30 to 50% reduction in annual output. There has to be an expansion of electricity supply if these shortages are not continue to act as a brake on economic growth."

The projects would thus appear to be relevant in relation to the overall needs and priorities in the sector.

3.4 Performance/Results in relation to Targets

3.4.1 First Year of Cooperation

The Programme Document for the first year of cooperation lists the expected results. The following is the Consultant's best assessment of whether these were attained or not:

Institutional Development	Attainment
1. Improved management capability	yes
2. Efficiency in planning of operation and maintenance increased	yes*
3. The organisation manual ready	no**
4. New accounting system implemented	no
5. The two Sister Companies have developed closer relations	yes

*However, instruction on operation and maintenance of power plants was postponed, evidently because the activities associated with the diesel generator in Assab became more costly than originally estimated.

**There was not sufficient time to finish the organisational manual during this first phase. However, it was prepared during the extended cooperation phase.

Master Plan	Attainment
Expected result was a Master Plan which described an optimal, cost efficient proposal for development of EEA's production and transmission facilities up to year 2000 with a brief outlook for the following 10-15 years and elaborated alternative scenarios of load development*	yes

*Although the Master Plan was produced it should be noted that an updating of it was considered necessary and suggested to be included already in the subsequent Feasibility Study carried out by SWECO.

Spare Parts Fund	Attainment
Increase the availability of existing generating capacity	yes
Increase the generating capacity by refurbishment of old units	yes
Increase the efficiency to some extent	yes
Improvement of the reliability of the power supply	yes
Improvement of the economy by lowering the cost per produced kWh	yes

The objectives as listed in the Programme Document appears to have been fulfilled:

Institutional development
1. Strengthen the Management capability of EEA
2. Increase the efficiency in the planning, operation and maintenance field and in the accounting system.

The methods to reach these objectives were:
- Exchange experience in management of an electric utility
- Support EEA in preparing an "Organisation Manual" for EEA including: Organisation chart, Duty descriptions and Authority rules

Master Plan
To create a Master Plan for the development of generation and transmission up to the year 2000.

Spare Parts Fund
To keep in operation the existing generating capacity, which is of vital importance for EEA to cover the present demand of electricity in Eritrea.

3.4.2 Extended Cooperation Period

A. Sydkraft's Intervention

For the extended cooperation period, the expected results are not explicitly expressed in Sydkraft's contract. They are however implicitly embedded in the text. The Evaluation Consultant has attempted to extract these and assess whether they were attained or not. Refer Appendix 4.

Although there are a lot of "NO" in this assessment, the Evaluation Consultant believes that Sydkraft's contract was fundamentally too ambitious in relation to the available time (up to 1994-06-30) and the number of visits. In any case EEA is very happy with the work performed by Sydkraft, although EEA had not been formally informed of Sydkraft's actual contractual obligations.

Although the Option of carrying out a Tariff Study was included in Sydkraft's contract, no such study was carried out. It is understood that EEA preferred this allocation to be used for training of operation and maintenance of diesel generator stations.

The objectives stated in Sydkraft's Contract dated 1994 02 25 have basically been met:

Institutional Reinforcement
To strengthen the institutional capacity of EEA including establishment of the governing rules and regulations for its mission as producer and distributor of electricity throughout Eritrea.

Spare Parts Fund
To give a more long lasting improvement of the generating facilities of the existing power generation units within the limit of the financial contribution.

The phrase "including establishment of governing rules and regulations" for the Institutional Reinforcement can of course be interpreted in different ways. It is, however, clear that there is still some work remaining before all rules and regulations are legally in place.

B. Sweco's Intervention

The objective for the SWECO Contract seems to have been attained:

Produce a Feasibility Study, meeting international standard requirements, for the generation and transmission expansion of the interconnected system project.

3.5 Actual Cost vs. Budget

First year of cooperation (budget 8 MSEK)

Sydkraft; consultancies	995 540
Sydkraft; spare parts	1 321 176
Sydkraft; spares and materials	5 993 300
TOTAL	8 310 016

Extended cooperation (budget 20 MSEK)

Sydkraft; consultancies, basic alternative	1 765 200
Sydkraft; telecom study, tariff study, framework follow-up	407 000
Sydkraft; procurement of spares	10 500 000
Sydkraft; procurement of cables	1 400 000
Sydkraft; unforeseen costs	1 500 000
Sydkraft; procurement of spares (950407-951201)	1 360 667
SWECO; consultancies	1 609 356
Cars bought for SWECO by SIDA	420 000*
TOTAL	18 962 223

* The exact figure for these cars is not known.

3.6 Actual Time spent in relation to original Time Schedule

First year of cooperation:

Sydkraft:	
Institutional Support:	Refer Appendix 5
Master Plan:	
Draft Master Plan was to be ready by February 1993	Was presented in May 1993
Final Master Plan was to be ready by May 1, 1993	Final Master Plan presented early June Complete Master Plan distributed mid June
Spare Parts:	
Arrival of spare parts to EEA set to February- June 93	Bulk of spares in July but some earlier and some as late as end 93

Extended cooperation

Sydkraft:	
Institutional Support	Refer Appendix 5
Spare Parts (No date stated)	
SWECO's Feasibility Study	
Draft was to be ready by May 15, 1995	To EEA by June 20, 1995
Final Report was to be ready by June 15, 1995	To EEA in July, 1995

Although there would appear to be some delays in the execution of certain tasks in relation to the original time schedule, EEA has no complaints about any delays.

3.7 Assessment of Efficiency of Project Activities

The projects have contributed to an increase in the useable installed capacity and provided for a more effective production and thus increased the energy production. The reliability of the generating stations and the transmission/distribution networks increased and thus provided for a more reliable power supply in the country. The assistance has been very timely, flexible and efficient during the period after independence when EEA faced enormous problems in repairing and rehabilitating the power system to satisfy the suppressed demand.

The projects contributed to an increased installed capacity of 7 MW by 1994. It is probable that a considerable portion of the increased yearly energy sales between 1993 an 1995 was made possible by this

increased capacity. The increased energy sold was 23 207 MWh/year and corresponds to some 20 MBirr in sales.

However, the large costs during power cuts is not the financial costs, but the socio-economic costs due to disturbances to industry, commerce and administration. In Sweden this cost has been estimated to about 30 SEK/kWh. In Africa the value is estimated to be lower, e.g. the World Bank has used figures between 0.5 - 1.0 USD/kWh. The socio-economic savings to Eritrea of having the extra 7 MW generating capacity can thus be estimated to at least $10 million/year.

The projects supplied the Eritrean Authorities with authoritative information for decision making on the best way to expand the systems. They also provided a planning readiness for increased production capacity and extended transmission/distribution networks to keep in step with the increased demand.

3.8 Organisation and Implementation, Contractual Relationship, Roles and Responsibilities

The design of the project implementation appears to have suited EEA very well during this initial period. Although the cooperation has been coined "sister cooperation", the impact of the support has been mainly on rehabilitating the power system rather than to develop the efficiency of the organisation through capacity building, organisational development and training. The extreme lack of generation capacity, the war damaged transmission and distribution network and the few trained top management staff at EEA meant that eliminating bottlenecks in the electricity supply system was (understandably) prioritised to the organisational activities.

The isolation EEA and Eritrea had suffered as a result of the protracted war had meant that EEA to some extent had missed the latest developments in the power industry technology and the office rationalisations based on the IT revolution. The sister cooperation allowed EEA to quickly pick up some of this information.

It appears that EEA in particular appreciated the way the diesel generator installation in Assab was implemented, i.e. the concept of learning by accompanying someone who is actually doing an installation seems to have been particularly successful.

As EEA is already contractual partner for both other consultancy and contractor contracts, it could be argued that any future Sida supported contracts should have EEA as contractual partner. It is assumed that it was due to an administrative slip-up, that EEA had not been formally informed of Sydkraft's contractual obligations during the extended period.

4. SECTOR ANALYSIS

4.1 The Energy Sector in a National Perspective

4.1.1 Laws and Regulations pertaining to the Sector

The applicable Legislation appears to be from the period before 1991 when Eritrea was under administration from Ethiopia. It seems that the Ethiopian regulations as yet have neither been revoked nor have specific new rules been legitimised nor new regulations introduced. Information obtained indicates that work is in progress on writing Laws and various regulations.

4.1.2 Organisational Set-Up

The responsible Ministry is the Ministry of Energy, Mines and Water Resources. This Ministry has a Department for each of these sectors, i.e. Energy, Mines and Water Resources.

The Department of Energy is involved in three main areas, presumably in addition to an overall energy planning and policy making role. It deals with renewable energy sources, training and with matters relating to oil exploration, testing and permits.

Eritrea Electric Authority, EEA, is mandated to generate, distribute and sell electricity in Eritrea. EEA has been incorporated under standard Company Law and thus operates within a commercial framework. However, presently EEA is still responsible to the Ministry and requires the Ministry's approval of tariffs, operating budget and capital programme.

It is understood that the Government is taking steps to legalise EEA as a self managed utility. This would see the Government maintaining ownership, but operating as a large shareholder in any other company, i.e. appointing the Board of Directors but then allowing the company management to make commercial decisions.

4.1.3 Energy Consumption

Studies in the 1980s indicate that the energy consumption in Eritrea was about 9,000 GWh or 740,000 tons of oil equivalent of which 82% was from biomass (wood, charcoal, animal waste and agricultural residues), 16.8% from oil products and 1.2% from electricity, all of which is still generated from oil.[1]

During 1994, per capita consumption of commercial energy (i.e. excluding traditional biomass) was around 0.06 ton of oil equivalent (toe). Including biomass the per capita consumption of energy in Eritrea is 270 Kg of oil equivalent as opposed to 710 Kgoe, the average of the world developing countries. The energy consumption was 77.2% for household use, 14.08% for industry, 7.9% for transport and 1% for agricultural and other activities.[2]

4.1.4 Energy Resources

Eritrea's National Power System

EEA operates two systems whose source of generation is all thermal:

The Inter Connected System (ICS) supplies the city of Asmara, the Port of Massawa and several other small towns which are situated along the 50 kV transmission line which links Asmara with Massawa. The distribution system in Asmara and Massawa is 5.5 kV for the medium voltage and 220/127 V for the low voltage networks while the towns along the 50 kV transmission line (namely, Nefasit, Mai-Habar, Embatkala, Ghinda, Upper and Lower Dongollo) have distribution systems of 15 kV medium voltage and 380/220 V low voltage.

The Self - Contained System (SCS) consists of ten isolated supply centres which are located all over Eritrea. The distribution systems in the major towns of Assab, Dekemhare, Keren and Mendefera are all 15 kV and 380/220 V for medium and low voltages respectively.

Regional Cooperation

Integration of electric power systems amongst the IGADD countries of the Horn of Africa would have the major advantage of increased security of electricity supply. Countries like Ethiopia, which generates cheaper hydro-electric and geothermal power could export excess power to countries like Eritrea, which generates more expensive electricity through diesel or fuel oil. Preliminary discussions about cooperation between Ethiopia and Eritrea, however, seems to be on hold as Ethiopia has not got any excess power at the moment.

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[1] Figures from 1984, Cessen Ansaldo Finmeccanica energy survey.

[2] Ministry of Energy, Mines and Water Resources, June 1994

Hydro Systems
There is potential for large scale hydropower exploration in the Tekezze River basin. Sites of good hydropower generation have already been identified. Such hydropower projects need joint venture development schemes with Ethiopia. However, both countries have shown interest in such developments. Although most other rivers are not perennial, there is some hydro potential capacity also in the rivers Barka and Mereb-Gash.[3]

Around the present Beleza power station, the Italians had once installed an intricate system of several reservoirs and pumping stations feeding two hydroelectric generating stations.

Solar Energy/Photovoltaics
Solar energy is a very promising source of electricity for Eritrea. In spite of high radiation levels, however, the current contribution of solar energy to the national energy consumption is negligible.

Solar energy can be used directly or indirectly. Solar thermal systems harness solar energy directly by means of collectors and the heat is used for water-heating, drying, cooking, space-heating, and minor electricity generation. Solar photovoltaic technology is the direct conversion of sunlight to electricity through photovoltaic cells. These are already is use in Eritrea. Since 1991, the Department of Energy has been involved in the installation of a number of PV installations in the rural regions of the country. To date 60 rural school lighting systems, 35 water pumping systems and 21 health centre electrification systems. There are also a number of other installations, some of which are purely private.

Oil Products
Taking into account that electricity is produced by oil driven thermal generating units, oil actually contributes 18% of all primary energy supply in the Eritrea. A total of about 200,000 metric tons of oil products of all types has been consumed in Eritrea during 1994. More than 50% of this is consumed in the transport sector. Crude oil is imported and refined at the old refinery at Assab. This refinery needs substantial amount of foreign currency to renovate it and expand it if it is to meet the growing demands of oil supply to both Eritrea and Ethiopia. However, a recent ESMAP Report[4] recommends that the refinery is closed down and that the required oil products are imported in stead.

There are programs to expand the supply of liquefied petroleum gas, LPG, to the urban areas and Kerosene to the household sector but there are constraints due to limited depot sizes and lack of trucks for the distribution.. A 2000m3 capacity LPG storage depot is being planned in the port of Massawa. It is hoped that increased supply of LPG and Kerosene will diversify energy supply and thereby reduce the dependence on biomass.

Estimates as to oil and natural gas reserves lying within Eritrean territory vary enormously. In 1967 a 500,000-cu metre/day gas geyser blew for 55 days, and the World Bank as well as private experts are optimistic. The liberal Petroleum Operation Proclamation of November 1993 allows for 25 years' development and production of hydrocarbons with renewal periods of ten years. In late 1995 the Government signed a seven-year prospecting contract with a US-based oil company.

Geothermal
Preliminary studies conducted in Eritrea on prospects of geothermal energy are promising. A UNDP-sponsored hydrological study, carried out in 1970 to 72, shows that the Danakil Depression between Irafale near Zula, and Dallol on the Ethiopian side has intense thermal activity. Studies estimate the geothermal potential to be in the order of 150 MW. However, further feasibility studies and exploration activities are required. Both involve capital-intensive drilling activities and sophisticated technology which could only be done by foreign companies.

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[3] United Nations Water Conference 1976; ECA 1976
[4] No. 179/96, Ethiopia Energy Assessment

Biomass
All rural communities in Eritrea (estimated to be 80% of the total population) as well as most household families in the urban areas and some commercial enterprises like bakeries and brick manufacturers, depend on biomass fuel for energy. The overall household energy consumption is 98.6% from biomass out of which wood and charcoal accounts for 83.61%. This has resulted in fast deforestation of the shrubs and tree cover and consequent alarming degradation of the environment. The forest cover in Eritrea has gone down from about 15% of the land surface in the 1940's to about 0.4% or merely 53,000 hectares of forest cover now.

The Department of Energy has commenced work in biomass combustion efficiency with research activities to improve the design and thermal efficiency of local cookers and stoves. This includes those using wood, electricity and LPG as fuels.

Wind Power
No systematic wind pattern studies have been done so far in Eritrea. Incomplete airport meteorological data indicate that at least the Assab and Tessenei areas generally have viable wind velocities for electrical generation.

In fact localised wind velocity measurements have shown that the Assab area is one of the most suitable sites for wind to electricity conversion in the world. Between 1968 and 1978 annual mean wind velocities of more than 9 m/s (at 10 m above ground) were measured at certain locations near Assab.[5] A Wind Power Feasibility Study to further develop this concept has been proposed.

Environmental Concerns
Environmental issues will be handled by the newly created Eritrean Agency for the Environment, which falls under the Ministry of Agriculture. Environmental Impact Assessments are carried out under the responsibility of each sectorial organisation.

A National Environmental Management Plan has recently been elaborated. The environmental concern expressed in relation to the energy sector was mainly the deforestation due to the war and the use of firewood for cooking in the rural areas. Rudimentary considerations are taken during the operation of diesel power plants.

4.1.5 Significance of Electricity Supply in a Development Perspective

Eritrea has inadequate energy sources to meet the requirements of the economy. Solving the energy shortage crisis is one of the national challenges, in order to improve the livelihood of the people and to assure the smooth progress of the general economic development of the country.

At the moment Asmara (around 400 000 inhabitants) consumes about 2/3 of the available electrical energy and Massawa and Assab (around 40 000 and 50 000 inhabitants respectively) basically the remaining 1/3. In other words, about 1/6 of Eritrea's population, located in the major urban centres consumes Eritrea's electrical energy. The existing electricity shortage, however, has become a major constraint to recovery and growth of Eritrea's destroyed economy. The World Bank estimated that 30 to 50 percent of Gross Domestic Product of the country was not being realised due to shortage of electric power.[6]

The role of electricity in the overall policy for development of the country is critical. The primary economic development objective of the Government is to promote balanced regional economic growth in Eritrea. Electricity, as a critical input to the economy, needs to be available in the depressed regions if the policy of balanced economic growth is to work. This requires wider distribution of electricity, away from urban and into the rural regions.

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[5] See also "Wind Energy Survey in Ethiopia": The Solar and Wind Technology Volume Number 4, 1988
[6] World Bank Country Economic Memorandum November, 1994

4.1.6 Private Participation

In its Macro-Policy document dated November 1994, the Eritrean Government limits the role of the public sector to the provision of necessary infrastructure and investment in human capital. It underlines that the private sector is the lead actor in the economic activities and is allowed to participate in all sectors with no restrictions and discrimination. At the same time, in view of the present dearth of capable entrepreneurs, it sees a need for a pioneering and catalytic role to be played by the Government. However, any public sector participation in productive economic activities will be on a strictly competitive basis and will be guided by the principles of the market. The ultimate objective of the Government is to withdraw completely from such areas and leave them to the private sector.

In its Guidelines for Policies & Strategies for Development dated June 1994, the Ministry assumes that because private investments in the electric power sector may not have a fast return in cost recovery, basic investment in infrastructure in this area is expected to be done by the Government. However, long range investment by the private sector is to be encouraged.

Although the EEA presently has broad-based managerial autonomy in as far as its internal operations are concerned, it is under de-facto regulation of the Ministry. This currently precludes any participation of the private sector in EEA's operations. If complete legal independence is granted to EEA, as envisaged, private sector involvement in the electricity sector could be possible both as an alternative source of investment funds and to obtain efficiency and competitiveness. This is likely to eventually require an independent regulatory body.

The Ministry presently assumes the role of a regulator. The role of the Government vis-à-vis EEA was described as approving tariff adjustments, appointing top Management, providing financial resources for investments and approving annual budgets. EEA is required to operate with profit and should in principle not be subsidised. However, as loans and grants are passed on very concessional terms, the capital cost does not reflect a commercial level. The Government should consider establishing some form of Performance Contract with EEA in order to monitor technical and financial performance aiming at decreasing tariffs.

There has been private proposals to set up large BOO generating schemes in Eritrea, but these have been rejected because the required guarantees to buy a certain (large) amount of energy have been deemed too onerous for EEA.

The World Bank has suggested some ways of introducing private capital into the sector, e.g. maintenance contracts in bids for the construction of new plant. Similarly, maintenance contracts for existing plants could be awarded that would include the supply of spare parts. The World Bank notes that EEA generally has sound technical expertise, so it envisages that these maintenance contracts would primarily provide foreign exchange to employ specialised technical personnel.

4.1.7 Tariff Systems and Principles in the Setting of Tariff Levels

The main social objectives of the Government on electricity are:

- the electricity sector should not be subsidised
- consumers should each contribute proportionally to the costs imposed by them on the system
- the very poor should be given access to low cost electricity
- the adequate and efficient supply of electricity throughout Eritrea is a primary objective

EEA's tariffs were trebled in December 1992, mainly to account for the loss in the value of the Birr because most of EEA's expenditure requires foreign exchange. The present tariffs are very high, about two times the international level. Serious efforts should be done to cut costs. Such measures could be to introduce more competition on different levels (fuel supply), out sourcing of activities, reducing dependency on thermal power etc.

Table 4.1: EEA's Tariffs

Group	Cate-gory	Type	Unit charge (Birr/kWh)	Service charge (Birr/month)	
				Single Phase	Three Phase
Domestic	71	Massawa&Assab<500 kWh	0.65	2.00	5.00
		Massawa&Assab>500 kWh	0.55	-	-
		Other Areas,<500 kWh	0.75	2.00	5.00
		Other Areas, >500 kWh	0.65	-	-
General	72	-	1.00	3.45	10.00
Street Lighting	73	-	1.00	3.45	10.00
Small Industry	74	-	1.00	-	31.10
Large Industry-LV	75	<100 000 kWh	0.75	-	31.10
		>100 000 kWh	0.50	-	-
Large Industry-HV	76	<100 000 kWh	0.75	-	31.10
		>100 000 kWh	0.50	-	-

However, further tariff adjustments are imminent. Merz and McLellan has carried out a tariff study, with new tariffs which appear likely to be adopted. Refer Appendix 6.

The proposed tariffs are set at long run marginal cost, calculated separately for each of the three regions of Assab, the rest of SCS and the ICS. Individual category tariffs are essentially cost-reflective and phased in over a period of up to 5 years. An exception to the principle of cost-recovery is a proposed "lifeline" tariff for basic household needs (up to 7 kWh per month). Peak/off-peak tariffs have been suggested for customers willing to respond to time-of-day signals through greater metering costs.

Consumers facing an increase in average unit rates, e.g. domestic consumers, have increases limited to 15%/year in real terms. Decreases in charges, e.g. for most industrial consumers, are proposed to be introduced immediately.

Implementation of tariffs which do not require new metering can be made when customers have been advised and the billing system adjusted. However, implementing new industrial category tariffs which require new two-rate metering is not so straightforward. The meters will not be able to operate at the existing supply voltage and also accommodate the proposed voltage changes. The industrial consumers supplied at LV number 1,500 and account for nearly 98% of all industrial consumers. M&M thus propose that new metering is installed for these customers only after the distribution projects for Asmara and Massawa around 1997 and that transitional single tariffs are used in the mean time.

There are about 40 customers supplied at HV and MV and these customers account for 70% of industrial electricity consumption, and about one third of total consumption on Eritrea. M&M propose to install new metering (for about 200,000 Birr) for these customers although they will become redundant when the voltage changes have been carried out. M&M consider it to be a small price to pay to introduce real economic signalling to about a third of the country's consumption.

It can be noted that as a result of the Tariff Study recommendations, electricity provided to EEA staff is now payable if they consume more than 150 kWh/month (previously 400 kWh). 150 kWh has apparently been selected as it represents the consumption by the average EEA employee, who earns 400-500 Birr/month. However, the intention is to eliminate this fringe benefit in the not to distant future. Considering that 150 kWh represents almost as many Birr per month, this is likely to be a considerably contentious issue.

It can also be noted that the previous tariff allowed a reduced rate in the ICS system for use of air conditioning units in Massawa. (Due to the hot weather in Massawa air conditioning was considered essential.) The proposed new tariff does not allow for a similar reduction and this would appear likely to create some opposition.

4.1.8 Financial Systems for the Energy Sector

The legal status of EEA is such that it cannot by itself negotiate and agree international capitalisation or investment loans. The central Government, through the Ministry, is currently taking the soft-loans on behalf of EEA, even though EEA is solely responsible for repayment of the principal plus interest (and stands the exchange risks!).

The Government has indicated that it wishes to see EEA operating as a financially-autonomous agency, with a tariff policy designed to recover all reasonable operating and capital costs. The Government may , however, continue to contribute to the financing of EEA capital projects through on-lending of external finance.

This policy is reflected in the loan from the Kuwait Fund for Belesa Power Station, which stipulates that EEA undertakes studies to make EEA financially and administratively independent and more efficient. EEA is further charged to implement a tariff which will generate revenues sufficient to cover operating expenses, including adequate maintenance and depreciation; cover taxes and interest on local and foreign borrowing; meet repayments on long-term indebtedness and progressively to leave a surplus for financing a reasonable portion of the cost of future expansion.

4.2. The Electricity Subsector

Electric energy accounts for only 1.2% of the total energy consumption. In 1994 56.78% of the electricity was consumed by industry, 22.08% by the household sector and the rest 21.14% by commercial consumers. Generally, supply of electricity is limited to the capital and other provincial towns in the country and is far short of demand. Average per capita consumption is estimated to be around 35 kWh per year.

Table 4.2: No. of Consumers distributed on System\Tariff 1995

System\Tariff	HV	MV	Domestic	General	Total
ICS	25	1,854	47,868	11,880	61,627
SCS		432	11,729	4,212	16,373

Assuming that the population in Eritrea is 3,500,000 and assuming that an average household has 5 members yield a degree of electrification of 11.7 %. In comparison, Mozambique had a 5-6% degree of electrification in 1993.

Table 4.3: Total billed Consumption (MWh/year) distributed on System\Tariff 1995

System\Tariff	HV	MV	Domestic	General	Total
ICS	33,270	18,769	25,398	18,538	95,975
SCS		5,334	10,762	6,109	22,205

The maximum demand for the ICS in 1995 was 24.26 MW with .8 power factor. The maximum demand for the SCS in 1995 was 11.702 MW and .8 power factor. At the end of 1995 three new Wärtsillä 5.7 kW diesels were commissioned at the Beleza power station. This solved the previous generation deficit. The present generating capacity is about 40 MW. There are no load curves available for the present load characteristics. In their Tariff Study from November, 1995 Merz and McLellan prepared standard day load patterns adjusted to take account of the forecasted growth in load for each of the five future years. Appendix 7 shows Merz and McLellans's indicative day load pattern for ICS - 1996.

Table 4.4: Average billed Consumption (kWh/year/Consumer) distributed on System\Tariff 1995

System\Tariff	HV	MV	Domestic	General
ICS	1,330,820	10,124	531	1,560
SCS		12,347	917	1,450

It appears that the present load has not grown as much as was expected. According to EEA, the old existing factories have not been able to work to full capacity as expected, when full electricity power became available. This is due to problems with their old equipment. However, EEA is confident that the load increase will come. The growth will come from new industries being set up, new housing installations, new rural electrification projects and new consumers. EEA is now working to eliminate the wait list of mainly 20 000 households waiting for an electricity connection. According to EEA, Lahmeyer's preliminary stabilisation studies have raised fears that the extra 80 MW generating capacity won't be enough by 1998.

4.3. Existing Situation at EEA

4.3.1 Financial Performance of EEA

The financial position of EEA is summarised in the abbreviated balance sheet from the proposed 1996 & 1997 budgets, shown as Table 4.5 below. On the basis of these indications of EEA's financial status and performance in 1994, 1995, 1996 and 1997, EEA has recovered from its previous weak financial position and has built up a modest capital reserve. The inclusion of new projects in recent years have lifted fixed assets to 73% in 1997 from a mere 28% of total assets in 1994, in spite of some decommissioning of plant in 1995.

Table 4.5: Balance Sheet (in '000 Birr)

I ASSETS	1994 ACTUAL	1995 ACTUAL	1996 ESTIMATE	1997 FORECAST
1. Current assets				
Cash and bank accounts	25,426	9,712	8,000	8,000
Accounts receivable	32,789	37,071	35,882	27,326
Inventories	88,880	98,060	105,000	100,000
Goods in transit	735	2,264	3,000	5,000
Total current assets	147,830	147,107	151,822	140,326
2. Investments	94	94	94	94
3. Fixed assets				
Fixed assets at cost	132,861	269,698	304,145	500,000
Less accumulated depreciation	74,495	79,972	96,312	113,228
Net fixed assets	58,366	189,726	207,833	386,772
TOTAL ASSETS	**206,290**	**336,927**	**359,749**	**527,192**
II LIABILITIES & CAPITAL				
A. LIABILITIES				
1. Current Liabilities				
Med.term loan current maturity	11,983	12,240	12,085	
Trade creditors	3,431	5,825	5,000	
Accounts payable	69,116	25,870	24,609	5,000
Capital charges payable				24,094
Provision for contingency & stock	26	26	26	26
Income tax payable	27,287	33,862	38,220	38,220
Total current liabilities	111,843	77,823	79,940	67,340
2. Medium term liabilities				
Med.term liab.-domestic banks	24,068	12,085		
Total medium term liabilities				
3. Deferred liabilities	2,726	3,182	3,700	4,300
4. Total liabilities	138,637	93,090	83,640	71,640
B. CAPITAL				
Capital	59,883	59,883	59,883	59,883
Reserve capital		72,588	76,588	76,588
Accumulated deficit less subsidy	7,770	17,766	24,438	13,081
Total capital	67,653	150,237	106,909	149,552
Long term liabilities		93,600	115,200	306,000
TOTAL LIABILITIES&CAPITAL	**206,290**	**336,927**	**359,749**	**527,192**

The Profit and Loss Statements, which are contained in the table below show that sales are expected to increase. However, the increased financial charges in 1997 for the new equipment results in an expected net deficit in 1997. The demand is obviously not deemed to have increased much by then

Table 4.6: Profit and Loss Statement (in '000 Birr)

	1994 ACTUAL	1995 ACTUAL	1996 ESTIMATE	1997 FORECAST
A- OPERATING INCOME				
Sales	105,277	108,990	128,000	144,000
Cost of sales	65,242	81,512	99,990	117,650
Gross operating margin	40,035	27,478	28,010	26,350
B- SELLING&DIST EXPENSES				
Sales salaries	1,922	2,553	5,000	5,500
Overtime	281	436	1,000	1,100
Depreciation	150	157	170	190
Other selling&distribution expenses	318	479	500	550
Total B	2,671	3,625	6,670	7,340
C- ADMIN&GENERAL EXPENSES				
Salaries fin&adm	829	1,259	2,500	2,750
Overtime "	49	116	150	165
Casual labour "	84	114	100	120
Depreciation	160	157	170	190
Sundries	200	200	200	300
Financial charges	1,004	1,288	3,500	19,590
Capital charges				
Miscellaneous	5,336	6,561	6,690	6,510
Total "C"	7,662	9,695	13,310	29,625
Total "B" & "C"	10,333	13,320	19,980	36,965
Net operating surplus	29,702	14,158	8,030	(10,615)
Other income	2,270	2,413	3,000	4,000
Net surplus before tax	31,972	16,571	11,030	(6,615)
Income tax	12,735	6,575	4,358	
Transfer to accum.a/c	19,237	9,996	6,672	(6,615)

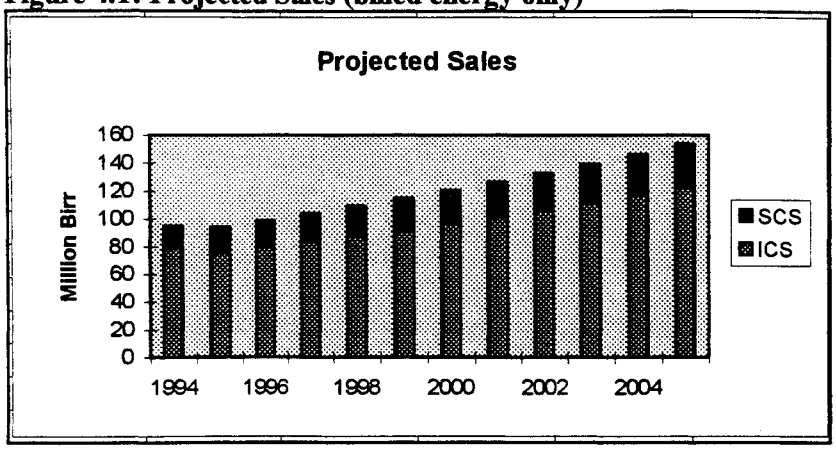
The most important items in EEA's operating account are the cost of fuel and materials for repair and maintenance.

Table 4.7: Fuel and Material Components of Operating Costs

	Proportion of operating costs, %					
	1992	1993	1994	1995	1996 Estimate	1997 Forecast
Fuel cost	70	70	64	64	46	47
Materials for repair and maintenance			19	19	23	23
Depreciation			6	6	16	15

It is interesting to note that EEA is assuming approximately 5% annual increase in billed energy:

Figure 4.1: Projected Sales (billed energy only)



4.3.2 Organisational Structure

It is envisaged that, in the near future, EEA will operate as an autonomous entity with its own board of directors. The proposed new organisational structure of EEA is illustrated in Appendix 8. The main actors are the Board of Directors and the General Manager with his top executive staff.

The five members of the Board including the Chairman shall be appointed by the State. Only one member of the board is proposed to represent the business community while three to four are proposed to be Ministers, of which one will be chairman.

4.3.3 Human Resources Situation

As shown in Table 4.8 below a trend towards higher qualified staff at EEA has been detected. The table gives an overview over the current human resources at EEA:

Table 4.8: EEA's Human Resources 1996

Categories	Male	Female	Total
Engineers - Professionals	14	-	14
Chemist - Profession		1	1
Professionals - Accountants	5	1	6
- Management	2	1	3
- Economists	2	-	2
- Business Administrators	2	1	3
Sub-professional - Accountants - Univ. Diploma	5	7	12
- Management - Univ. Diploma	4	-	4
- Law - Univ. Diploma	1	-	1
Technicians-Technical School - Diploma	201	20	221
Skilled Workers	312	-	312
Clericals	154	41	195
Custodian & Manual	19	4	23
TOTAL	7721	76	797

But, the computer literacy is low ..

Table 4.9: No. of Computer literate Employees/Classification 1995

Classification\No	No	Computer Literate, No
Professional Service	29	3
Sub-professional Service	243	1

Skill Works	251	
Clerical Service	194	11
Custodian & Manual	72	
TOTAL	789	15

EEA has not had any expatriates employed. However, expatriate consultants and contractors are sometimes assigned on bigger projects.

The general impression obtained is that up to now EEA has been fairly capable of operating and maintaining the various systems. The ratio of number of consumers per employee can be regarded as a reasonable indicator of the overall efficiency in the sector and as can be seen below, Eritrea fares well in a comparison with a couple of other African states. However, it is envisaged that the planned and on-going expansion of the systems will require training of the staff to cope with the new technologies.

Table 4.10: Ratio Consumers to Employees in Eritrea, Mozambique and Zimbabwe

Country	Eritrea	Mozambique, 93	Zimbabwe, ca 93
No. Employees	803	2,839	7,500
No. Consumers	78,000	136,328	330,000
Ratio	97	48	44

4.4 Sector Development Plan

4.4.1 Sector Development Plan

The Government's Macro-Policy document has the following Energy Sector Orientation: Develop the country's energy base through exploration and development of the country's potential gas and oil deposits, development of renewable energy sources, etc. The Ministry's Guidelines of June 1994 also highlights the development of national energy resources. The objectives stated in this document is "to ensure as much as possible the supply of adequate and equitable energy to the various productive and social sectors and the general public at low cost with economically justifiable means and without inflicting further damage to our environment".

4.4.2 Generation, Transmission and Distribution Improvements

An expansion of the power generating capacity and the transmission grid is implemented in accordance with the recommendations of the 1994 Feasibility Study on Generation and Transmission Expansion by SWECO. Today, EEA has an installed capacity of 40 MW thermal generation. 3 x 5.7 MW diesel generators were installed in Beleza at the end of 1995, when old, inefficient generators of totally 6 MW were decommissioned.

An additional capacity of 80 MW is planned to be installed in Massawa and commissioned during 1999. Under this project it is planned to install an 84 MW Thermal Power Generating Station in Hirgigo outside Massawa, erect a 132 kV transmission line from Hirgigo to Asmara, integrate with the ICS systems in Keren, Dekemhare and Mendefera through transmission lines of 66 kV and replace existing low voltage from 127/220 to 220/380 V and change all associated transformers. The existing 50 kV transmission line from Massawa to Ghinda is planned to be rehabilitated and changed to 66 kV. There is also a suggestion to install a 132 kV substation in Ghinda.

Previously discussed 66 kV extensions from Keren to Agordat and Dekemhare to Adi-Keih have been shown to be unviable at this stage. In addition, the demand prediction presented in the SWECO study has not been met at this stage. The main reason is said to be a lower increase in industrial production than anticipated. There is thus a risk that the investment will result in an over capacity for some time. No adjusted economic calculation for the project has been carried out.

Appendix 9 shows the existing and planned electricity network in Eritrea.

There are plans to rehabilitate the distribution systems in Asmara and Massawa. These systems have an old outdated 5.5 kV medium voltage distribution and 127/220 V for general lighting and power, with separate electricity meters. The plans are to replace these systems with 15 kV distribution, mainly through cables in Massawa due to the environment, but aerial lines in Asmara. The low voltage distribution would then be 220/380 V. A EU-financed Spanish consultant INYPSA is carrying out a Feasibility Study for the rehabilitation of Massawa and tender invitations have been sent out for a similar study in Asmara financed from a Swiss grant.

In addition the normal expansion of the distribution networks for the smaller cities are typically expected to include 2 km medium voltage lines and 5 km low voltage lines for each provincial town and year.

There are various plans and projects in the area of rural electrification. There are for instance a number of 15 kV extensions planned or underway from Mendefera to Debarwa, Kudo Felassi, Areza and Adi Quala. From Keren 15 kV extension lines are planned to Hegaze and Ela Berid.

4.4.3 Organisational Changes, Institutional Developments and Manpower Training

Currently each Division within EEA is responsible for training of its staff through courses, etc. The long term plans are to attempt to institutionalise the training, possibly involving expert participation.

The Department of Energy carries out research on renewable energy resources at a newly established and fairly well equipped Training Centre on the outskirts of Asmara. It receives assistance from a number of NGO's, e.g. WUS, OBS, OXFAM (earlier) and a Swiss NGO.

The Department has also started to conduct training courses for the energy sector. These include special courses in renewable energy sources, but also courses for the general electricity sector. Although the Training Centre has only been established for about 6 months courses have been conducted in basic electrical safety, grounding, etc. aimed at small scale contractors, but also courses for EEA foremen in simpler distribution techniques. It should be noted that the information and materials provided by Sydkraft in electrical Safety, etc. has not filtered down o the Training Centre.

The Centre has a Director, 2 expatriate engineers (one Ph.D. from the US and one engineer from Canada) and about 22 local Eritreans (including 3 engineers and 4 technicians). When the Centre runs courses it draws on experts from other organisations.

The Centre has 4-5 big buildings and plenty of spare area on a ca 2 ha plot on the outskirts of Asmara.

4.4.4 Operation and Maintenance of the System

The Generation & Transmission Division is responsible for operation and maintenance of the generation and transmission systems in the same way as the Distribution Division is responsible the distribution systems. Each Division presents yearly budgets, which includes for regular operation and maintenance activities. The budgets usually also allow for some expansion of the networks. The current operational budget is 207 million Birr (not subsidised).

To obtain an idea of the difficulties facing EEA in operating its network, refer to the following statistics over forced outages during 1995:

Table 4.11: Forced Outages, EEA, 1995

System	No. of Faults	Lost Energy MW	Unavailability, %	Unavailability, hr
ICS	306	20,080	13	1139
SCS	68	1,275	4	350

During the war in Mozambique between 1984-1992 several substations and line sections were attacked and damaged. During this time, mainly preliminary repairs were carried out to restore supply as quickly as possible. The following is fault statistics from EdM's Southern System 1993.

Table 4.12: Fault Statistics for Mozambique's Southern System 1993

	1990		1991		1992		1993	
	No	Hr	No	Hr	No	Hr	No	Hr
Eskom 275 kV	94	2001	185	1339	46	103	84	17
Dist. aerial net	1956	6148	1907	2189	1130	1058	944	791
Dist. cable net	753	1262	1022	863	385	351	206	127

To compare the above figures with an African country which has been at peace for a longer time, refer to the following statistics from Zimbabwe:

Table 4.13: Power Line Statistics from Zimbabwe, ca 1992

Voltage	Route Length Km	Substation MVA	Planned Outages h	Unplanned Outages h
330 kV	3,443.90	1,804	700	7
132 kV	1,021.00	840	57	51
110 kV	5.00	-	6	0.2
88 kV	2,081.90	794	860	110
66 kV	178.00	79	10	0

4.4.5 Energy Efficiency, Demand Side Management and Loss Reduction

To satisfy the demand of electricity certain supply side activities and investments are required, Supply-Side Management (SSM) covers most of the traditional activities of an electric utility. ***Demand-Side Management (DSM)*** on the other hand covers all the activities and investments which influence the efficiency of energy consumption, from the meters to its final use. Although the role of the consumers is crucial in DSM, the utility can support the consumers through its means and expertise.

To illustrate the linkage between the utilities and the consumers, let's see the consequences of a consumer's decision to buy an electric stove for the traditional Eritrean injera bread for 400-500 Birr: EEA then has to provide a 3 kW power demand capacity. Merz and McLellan has calculated the Long Run Marginal Cost of capacity in their Tariff Study. Thus the cost to the Utility to provide demand capacity for this cooker is typically:

Generator Capacity (SCS)	3x 1,731 Birr
Transmission	3x 2,970 Birr
Distribution	3x 4,163 Birr
TOTAL	3x 8,864 Birr = 25,592 Birr

An assumed couple of hours operation of the stove every second day, only means a few hundred Birr in energy charges per year. In view of the load characteristics of the Eritrean power system, with its two high peaks per day, refer Appendix 7, there appears to be ample scope of introducing DSM activities for peak lopping. Replacing incandescent bulbs with compact fluorescent substitutes, load shifting, etc., could be contemplated. About the only 'demand side management' measure EEA has taken so far is to provide stiff penalties for customers having too low power factors.

The Eritrean Government has carried out some Energy Audits in Asmara. Although no reports were available at EEA, the results indicated that there was scope for considerable improvements in this area.

The year round ***losses*** in 1995 were:

Table 4.14: Energy balance kWh 1995

Category\System	ICS	SCS
Production	117,773,164	26,894,825
Consumption billed	99,171,049	23,169,432
Losses	16%	14%

In Mozambique in 1993 the losses (comprising technical losses and unbilled consumption) was 32% (Northern System), 30% (Central System) and 11% (Southern System). A Loss Reduction Programme sponsored by Sida is attempting to reduce these high figures. A considerable proportion of the losses are due to non-technical losses. Total losses on the transmission and distribution systems in Zimbabwe have averaged just under 10% of energy sent out during the last five years up to 1994.

Losses at time of peak demand are significantly greater than average losses because the line losses follow an I^2R relationship. With a year-round average loss of 16%, the losses at peak demand can be as high as 24%. Thus loss reduction measures could contribute further to peak-lopping efforts.

In 1989, as part of technical assistance to Ethiopia, the Finnish consultant IV carried out some studies of losses in the EEA system. The surveys were all basically completed and the results about to be entered into computers in Asmara when war activities stopped further work. Nothing further has been done as far as EEA is aware.

4.4.6 Metering, Billing and Revenue Collection

The two voltages in the ICS systems make billing very cumbersome, in that a meter is required for lighting and another for power. EEA has therefore been studying different alternatives. A Low Cost Connection Project has been carried out on a Pilot basis. This has mainly involved load limiting devices, like Ready Boards. The South African Prepayment meter system has also been studied.

There is basically no theft or fraud in connection with electricity supply in Eritrea.

4.4.7 Accounting and Auditing

EEA has an Internal Audit Section carrying out internal audits regularly. External Auditors are engaged to audit the company. The most recent audited accounts of EEA relates to the financial year ending 31 December 1992.

As part of the Kuwait financed Belesa Project, an Accounting Study will be carried out. The objectives of the Study is to introduce and train EEA staff in accounting and finance systems complying with International Accounting Standards (IAS) and Internationally accepted accounting practices.

4.5 Other Financial Sources

4.5.1 Other Donors involved

As part of the power component of the Recovery&Rehabilitation Program for Eritrea, in 1994 and 1995 the Government of Italy provided $1 million for distribution material and IDA $3.33 million for distribution material, vehicles and equipment.

The following financiers/donors are reported to be involved in recent electricity sector projects:

<u>Belesa Station (3x 5.7 MW generators)</u>
Kuwait Fund, $ 16,5 mio, roughly including:
$ 14 mio for Generators
$ 1 mio for Fire Fighting Equipment
$ .2 mio, Consultancies (by Kennedy and Donkin)

$ .25 mio for Tariff Study (recently completed by Merz & McLellan)
$ .3/.4 mio for Accountancy Study (about to be tendered)
$ .5 for procurement of distribution material

Massawa Project (80 MW generation, 80 km 132 kV and 160 km 66 kV lines and 5 substations):
Saudi Fund, $ 35 mio (generation 20, transmission 11, engineering 1 and contingencies 3)
Kuwait Fund, $25 mio(generation 22, engineering 1 and contingencies 2)
Abu Dhabi Fund, $25 mio (generation 22, engineering 1 and contingencies 2)
BADEA, $ 12 mio (generation)
OPEC, $ 5 mio (generation)
ITALY, $ 25 mio (transmission lines & substations)

Asmara Distribution System Expansion
Swiss Government, SFr 5 mio (Feasibility Study 1 and Implementation 4)

Massawa (and surroundings) Distribution System Rehabilitation
(includes 50 km Massawa-Ghinda transmission line rehabilitation and change from 50 kV to 66 kV.)
EU, $ 12.5 mio

4.5.2 Need for Outside Assistance

The concluded financing arrangement for the new generator facilities in Massawa and associated transmission lines has gone a long way to clear the generation deficit. It is hoped that the plant will be on stream in 2 years time. The Massawa financing package does not include the 132 kV substation in Ghinda, which EEA is hoping that Sida will finance.

A lot remains to do in the area of distribution. Not only are the distribution networks old and outdated, but there are now new residential projects, hotels and factories coming on stream. There are 3-4 factories already starting in Ghinda that was not foreseen in the Sweco Study. There are 1470 new flats being constructed in Asmara for returning Eritreans and a similar project has started in Massawa. There will be a need for financing of the distribution rehabilitation in Asmara after the Swiss financed Feasibility Study has been completed. The EU funding discussed for the Massawa distribution rehabilitation, might possibly be enough for that work. The SCS are generally in a more fortunate situation than the ICS distribution networks. Most of the SCS towns were totally destroyed during the war and when rehabilitation of the distribution networks was carried out, 15 kV and 380/220 V was chosen. Although those networks are reasonably new and in a fairly good condition, there is a need for interconnection of some of those SCS with the ICS.

EEA needs further institutional strengthening. The previous strategy with short term visits seems to have suited EEA. However, it is envisaged that the assistance from the Swiss financed consultant to set up a distribution planning office will be on a resident basis. The Massawa project should also provide considerable resident assistance in generation/transmission matters.

There is a need to assist with institutionalisation of the training activities at the Training Centre. Sydkraft, Lahmyer and soon the Swiss financed consultant will all have given training in distribution, but there appears to be a need for training in transmission.

Peak lopping measures through demand side management activities appear to have high potential. In addition, as the considerable losses in the EEA systems further accentuate the demand peaks special loss reduction measures should be considered.

5. RECOMMENDATIONS

5.1 Proposal from EEA for Utilisation of Sida Financing (SEK 40 million)

According to EEA the agreed cooperation in the field of energy between EEA and Sida stipulated two separate agreements namely:

1. The first agreement period to cover the time up to July 1994 with an amount of 28 MSEK
2. The second agreement period to cover the time from July 1, 1994 up to July 1, 1996 with an indicative amount of 40 MSEK

EEA feels that the first agreement, utilisation of 28 MSEK was successfully realised to the satisfaction of both parties. However, the second agreement, utilisation of 40 MSEK was stopped when preparations were underway to identify projects to be financed under the agreement.

In anticipation of a continued cooperation between EEA and Sida, EEA has prepared a list of projects and sub-projects that could be financed out of 40 MSEK:

1. Construction of a 132 kV substation and associated switchgear at Ghinda. The substation is to be connected to the Massawa-Asmara 132 kV new transmission line to be constructed with the new power plant in Massawa to be realised in 1997. (Total $ 3,440,000)	23 MSEK
2. Relocation and rehabilitation of 1 x 2.5 MW generator set in Assab. The generator was installed by the Ethiopians during the latter part of the war. Although it is relatively new, it has worked continuously for long periods. It is planned to be moved from the Port Authority area to EEA's generating station. As previously the cooling was done with sea water, the new location requires radiators for closed circuit cooling. (Total $ 1 208 000)	8 MSEK
3. Rehabilitation of Belesa, Gajjiret and Asmara Centre Substations, which have operated for more than 25 years, involving 66 kV circuit breakers, disconnectors and bus bars. (Total $ 1 140 000)	8 MSEK

In addition, EEA has verbally expressed an interest in:

4. Financing of the rehabilitation of Asmara distribution network.
   Involves change from 5.5 kV & 127/220 V to 15 kV & 380V/220V.

5. Institutional support.
   Latest trends, increasing efficiency (perhaps loss reduction) and training.

5.2 LFA Problem Analysis

A problem analysis of the electricity sector in Eritrea suggests that the core problem is a generally inadequate electricity supply, i.e. unmet demand, poor quality and poor reliability of supply. Refer Appendix 10.

The main causes are the effects of the long lasting war. Insufficient investments have been made in new generation, transmission and distribution systems resulting in insufficient generation capacity and inadequate functioning of equipment and systems, including high losses. Outdated transmission and distribution equipment, non-standard LV and MV systems, a large number of generators, insufficient skilled manpower and insufficient maintenance to generators due to lack of reserves have all contributed to the system and equipment problems. The losses in the networks are due to the poor condition of the networks and high wastage at the consumers due to insufficient demand side management. A previous economy based

on subsidies, previous low tariff tariffs and inefficient billing systems have all contributed to the lack of funds

The effect is severe limitation of the industrial and commercial production and expansion, increased use of limited biomass resulting in desertification and pollution, social stress and sub-optimum use of resources for development, factors which all have negative effects on the development of the country.

The strategy for rehabilitation of the sector is to rapidly eliminate the current bottlenecks in the electricity supply systems to allow EEA to carry out remaining improvement measures in an orderly and organised manner. The proposed strategy for a possible Swedish intervention is to complement other financiers and donors in this endeavour.

The immediate objectives would be to provide adequate electricity supply. Refer Appendix 11. The activities that would yield this are:

Manpower training and institutional strengthening coupled with implemented transmission and distribution projects resulting in properly functioning equipment and systems; increased generating capacity; loss reduction and DSM measures; and revised tariffs and billing system.

5.3 Recommendations for Sida Interventions

As some of the above listed problems are already being attacked by other donors/financiers, the following interventions are recommended to be considered for Sida financing. The projects have been divided into three categories:

i) commercially viable investment projects, which could be considered for concessionary financing;
ii) soft-ware cooperation, i.e. studies, training, etc. which could be considered for grant financing, and
iii) investment projects with a social profile which are not fully commercially viable. These projects could be financed by a mixture of grants and concessionary credits.

It is assumed that any project(s) to be selected must be subject to a positive appraisal of a detailed proposal and for investment projects, a positive feasibility study.

5.3.1 Possible Projects to be considered for Concessionary Financing

1) 132 kV substation in Ghinda (Estimate by EEA m$ 3.44, mSEK 24)
There is considerable industrial, agricultural and mining development in Ghinda requiring a dependable power supply. However, EEA has been advised that the economic benefit from installing a new 132 kV substation needs to be ascertained.

It is envisaged that a Consultant would be required to carry out the Feasibility Study, but that that EEA can prepare tender documents for the supply and installation of the substation.

2) Rehabilitation of parts of Asmara distribution network
The Asmara distribution network is old and obsolete. The medium and low voltages 5.5 kV and 220/127 V need to be changed to the standard 15 kV and 380/220 V. The rehabilitation is likely to require participation from several donors/financiers. A feasibility study is ongoing with Swiss financing. It has been indicated to EEA that any Swedish financing would be subject to a positive appraisal of the economic viability and the availability of funds.

5.3.2 Possible mixed Grant/Concessionary Projects

Some projects could possibly qualify for "development credits" or some mixture of grant/consessionary financing. Some projects which have been tentatively discussed with EEA and which fall into this category

are for instance some rural electrification projects and the rehabilitation of the Asmara distribution network. EEA was advised that the grant elements would then have to be covered within a possible total allocation to the Energy Sector.

3) Rehabilitation of Belesa, Gajjiret and Asmara Centre Substations(Estimate by EEA m$ 1.14, MSEK 8)
These substations are more than 25 years old and need replacement of switchgear equipment. Some parts were already replaced during the previous cooperation periods. Due to the limited funds available at that time not all the old equipment was exchanged. It has thus been proposed by EEA that the remaining old switchgear is replaced.

4) Moving of a generator in Assab (Estimate by EEA m$ 1.21, MSEK 8,4)
As Sida only finances diesel generators in exceptional cases, the proposed project to move a diesel generator in Assab is not considered to be a possible project for Sida financing.

5) Rural electrification
Some rural electrification projects around Asmara and other major cities could be considered for financing. Many extension projects are underway, financed with internal sources[7]

Under the Massawa project both Mendefera and Keren will receive new 66 kV supply and be interconnected with the ICS. All of these lines have priority status due to significant development in the areas. Here again, EEA was advised that any project must show economical feasibility before they can be considered

5.3.3 Possible Projects to be considered for Grant Financing

It is understood that any Projects to possibly be financed under this heading would be restricted to the annual allocation of tentatively 10-15 MSEK. A selection of the most prioritised projects would then be necessary.

6) Institutional strengthening
- Assistance to develop the regulatory framework,
E.g. drafting Electricity Law, formulating a Performance Contract for EEA, private sector participation, establishing regulatory functions etc. Such development would be needed to improve the efficiency of the sector and to facilitate private and public capital financing of investments.

- Training
Training needs assessment, human resources development plan, implementation of training activities etc.

- Demand side management (DSM)
The special Eritrean electricity demand characteristics appear to lend itself particularly well to DSM measures in order to cut the peak demands.

- Loss reduction measures
There is a considerable saving potential by reducing the current high energy losses in the various systems. In particular as the high line losses further accentuates the high demand peaks.

7) Wind power studies
The Ministry of Energy has proposed a feasibility study of a Wind Farm in the Assab area. However, there is a need to investigate the national use of wind-power. Such an initial study would aim at investigating the potential use of wind power, including relevant technical, financial and operational aspects. It would form a basis for setting a strategy for extended use of wind-generated power in remote areas. Wind velocity

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[7] 15 kV extensions from Mendefera to Debarwa, Kudo Felassi, Areza, Adi Quala, and a 15 kV extension from Keren to Hegaze and Ela Berid

measurements in certain areas of Eritrea have identified very favourable sites for wind to electricity conversions. A wind power study was included in the previous cooperation but was omitted due to limited funds.

8) Energy Master Plan
The Ministry has expressed interest in elaborating a national plan for the utilisation of its energy resources. Such a plan would include a mapping of the energy resources and form the basis for setting long-term priorities for the use of energy, strategies to meet the demand, demand-side management etc. The Ministry of Energy will send a Terms of Reference to Sida within a month where details are elaborated.

5.3.4 Project Activities

Typical activities for each project or combination of projects would comprise:

	1997												1998											
Event\Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Feasibility Study/Appraisal	—																							
Tender Documents		-																						
Tendering		—																						
Tender Evaluation			—																					
Award of Contract				.																				
(Detailed Work Plan)				——																				
Project Activities						—		—		—		—		—		—		—		—		—		
Seminars, workshops								-						-						-				

TERMS OF REFERENCE

RESULT ANALYSIS OF PREVIOUS SWEDISH SUPPORT TO THE ENERGY SECTOR, ERITREA

1. BACKGROUND

The Swedish support to the energy sector in Eritrea started in 1992 in the form of a twinning arrangement between Eritrea Electricity Authority (EEA) and Sydkraft. During 1992, 8 million SEK were disbursed from Sida mainly for procurement of spare parts for existing generation facilities.

In 1993/94, a cooperation agreement between Sida and EEA of 20 million SEK was signed. The agreement was later prolonged to 30 June 1995. The agreement included a continued twinning arrangement with Sydkraft (2.2 million SEK), procurement of spare parts and equipment (15 million SEK) and a feasibility study on generation and transmission expansion carried out by the consultant SWECO(1.9 million SEK).

Due to a dead-lock between the Eritrean and Swedish governments in 1994, the Swedish development assistance funds to Eritrea were frozen. The cooperation agreement between Eritrea and Sweden expired on 30 June 1995. Since the dead-lock has now been resolved, a continued cooperation within the Energy sector is under consideration.

2. OBJECTIVES

The prime objective of the mission is to analyse the results of previous Swedish support.

Another objective is to screen possible areas for future support.

3. SCOPE OF WORK

3.1 Result analysis of previous Swedish support

The Consultant shall review Sida supported activities included in the Swedish assistance during the period 1992-1995. The following shall be assessed for each of them:

i) Impact of the projects on the sector/society (achievement of the development objectives)

ii) Relevance of projects in relation to the overall needs and priorities in the sector

iii) Performance/actual results in relation to planned targets - to be assessed i. a. on basis of indicators of achievements and milestone set out in project documents, job descriptions, Terms of Reference's etc.

iv) Analysis of why/why not results where obtained

v) Actual costs vs original budget and actual time spent in relation to original time schedule

vi) Assessment of the efficiency of project activities (results/input)

vii) Manner of organizing and implementating the project, including Contractual relationship, roles and responsibilities

The Consultant shall present his recommendations in respect to a possible future sector support. This will be done on basis of the sector review and the results of previously supported projects. Furthermore, the Consultant shall take into account the expertise and experience gained by the various experts/companies involved. The need for assistance in various areas and the magnitude of the support programme will be of major importance.

3.2 Sector analysis

3.2.1 The Energy Sector in a National Perspective

The Consultant shall briefly present and comment on the organizational set-up of the sector from the political, regulatory and operational level. Furthermore, a brief overview with comments shall be made regarding the

- economic, social and environmental significance of electricity supply in a development perspective
- laws and regulations pertaining to the sector
- private participation in the sector
- tariff systems and principles in the setting of tariff levels
- financial systems for the energy sector

3.2.2 The Electricity Subsector

The Consultant shall give an overview of thr present and forecasted electricity demand divided into subsectors, fuels, user groups etc.

The Consultant shall briefly present the existing physical system for generation, transmission and distribution within the country, including interconnections with other countries. Key information such as installed capacity, actual production,

import and export of power, consumption, technical and non-technical losses, percentage of population served etc shall be presented and commented upon.

3.2.3 Existing situation at EEA

The Consultant shall present and assess EEA's present capability in coping with its various tasks. Specifically, the Consultant will i.a. present and assess the organizational structure, human resources situation in various areas and levels in the organization (competence/experience and number of personnel) and functional efficiency of the administration, e. g. the number and role of expatriate personnel within the organization.

The Consultant will present an overview of all outside assistance to EEA by listing the agencies with their projects/programmes and budget allocations.

3.2.4 Sector Development Plans

The Consultant will present and assess EEA's overall strategies and plans i. a. regarding

- strengthened physical improvements with respect to generation, transmission and distribution
- organizational changes (if any), institutional development and manpower training
- operation and maintenance of the system
- energy efficiency, demand side management and reduction of losses
- metering, billing and revenue collection
- accountancy and auditing

3.2.5. Other financial sources

The Consultant will assess the need for outside assistance (financial, technical) in the implementation of important tasks and projects.

The Consultant will also give an overview of the involvement of other donors (fields of operation and volumes)

3.3. Recommendations for future support

Possible areas of cooperation will be identified. Each proposal shall include a description of main objectives, possible outputs, activities, tentative budget, critical external factors etc.

An indication of Eritrean priorities for the identified areas will be given.

4. METHODOLOGY

The study will include the following steps:

i. Literature collection and study
ii. Interviews with Sydkraft and Sweco
iii. Field trip to Eritrea - interviews with responsible officials at EEA and the Ministry of Energy, Mines and Water
iv. A brief seminar in Eritrea presenting facts and findings to Sida and EEA.
v. Final report

LFA methodology should be used whenever applicable.

5. TIME SCHEDULE AND REPORTING

The Consultant will spend 1-2 weeks in Eritrea during the month of July 1996. Facts and findings are to be presented to Sida and EEA at the end of the mission. A draft report will be presented to Sida not later than 2 weeks after the visit. The final report, including views from EEA and Sida will be completed before 15 August 1996.

PRINCIPAL CONTACTS

Ministry of Energy, Mines and Water Resources

Mr Tesfai Ghebreselassie	Minister
Mr Samuel Baire	Director General, Energy Department
Mr GebreMicael Temenwo	Acting Director General, Water Resources Department
Mr Mnat Berhane	Head of Energy Training Centre

Ministry of Construction

Mr Abraha Asfaha	Minister

Office of the President

Mr Berhane Abrehe	Director, Macro Policy & International Economic Cooperation

Eritrea Electricity Authority

Mr Abraham WoldeMicael	Director
Mr Habtu Ghebreamlak	Dep Director
Mr WoldeMicael Berhe	Transmission and Generation Division Head
Mr Weldetensae Haile	Distribution Division Head
Mr Tzeggai Amdehaimanot	Finance S/Div Head
Mr Muhammed Saud Shumay	Supply S/Div Head
Mr Hapte Selassie	Administration S/Div Head
Mr Tekle Hedru	Massawa Bransch Manager

Donor representatives

Inger Jensnäs	Swedish Councel
Garth Castrén	Ambassador of Finland
Rainer Baudendistel	Swiss Disaster Relief Unit
Mr Enrico Strampelli	Second Secretary for Technical Affairs, Delegation of the European Commission to Eritrea
Mrs Maria Ritta	Italian Embassy

Consultants

Nils Nilsson	Sydkraft International, Project Manager
Sören Petterson	SWECO

Ministry of Construction, Department of Roads

Mr Ioyb Ghirme	Head of Department
Mr Tegleberhan Ghebreyesus	Head of Operations
Mr Kidane Berhane	Head of Engineering

Municipality of Asmara

Mr Semere Negash	Head of Planning and Technical Department
Mr G/Meskel Yohannes	Architect, Planning & Tech. Dept.

Ministry of Transport

Mr Amare Afeworki	Head of Planning Unit

Contractors, Suppliers

Johan Sandstedt	Transelectric
Stefan Serlachius	Nokia Cables

APPENDIX 3

LIST OF PRINCIPAL REFERENCE DOCUMENTS

[1] Feasibility Study on Generation and Transmission Expansion, SWECO, July, 1994
[2] Eritrea, Options and Strategies for Growth, the World Bank, November 10, 1994
[3] Electricity Tariff Study, Merz and McLellan, November, 1995
[4] Energy Sector: Electricity. Organisational Manual, EEA, May 1995
[5] Guidelines for Policies & Strategies for Development, Ministry of Energy, Mines and Water Resources, June 1994
[6] Department of Energy, Energy Centre Programs, July 22, 1996
[7] Consultancy Services for Modernisation of EEA Accounting System, June 1996
[8] Consultancy Services for the Distribution and Voltage Conversion Study of Asmara
[9] Aide Memoir, World Bank Supervision Mission, Recovery & Rehabilitation Program for Eritrea, September 1995
[10] Proposal for Utilisation of Sida Financing, EEA document (received July 1996)
[11] Outline Cooperation in the Energy Sector, SIDA vs EEA, EEA document (received July 1996)
[12] Various internal Sida documentation relating to the Energy support to Eritrea
[13] Sydkraft's and SWECO's Consultancy contracts
[14] National Environmental Management Plan for Eritrea, 1995
[15] Energy Policy Document received from Department of Energy in July, 1996]
[16] Macro Policy Document, Government of Eritrea
[17] Etiopia, Energy Assessment, ESMAP Report No. 179/96

APPENDIX 4

PERFORMANCE/ACTUAL RESULTS IN RELATION TO PLANNED TARGETS

Sydkrafts Interventions during Extended Cooperation Period

Expected Results and attainment

	Attainment
Institutional Reinforcement	
External Framework:	
Proposal for governing framework	Yes
Report proposing Laws and Regulations governing electricity supply	No
Internal Framework/Organisation:	
Complete outline of new organisation	Yes
Instructions developed including task descriptions & job descriptions	Almost
Administrative routines & systems developed and implemented	Developed/ not implemented
Detailed rules for Board, General Manager, Departments, etc. prepared (After appointment of the top organisation)	Yes
Job description for key functions prepared (Before establishment of the new organisation)	Yes
Quality of Supply:	
Report	Yes
Programme for future monitoring established	No
Safety Regulations	
Seminar	Yes
Proposed structure for safety regulations elaborated	No
Commissioning diesel generators in Assab	Yes
Communication study	Yes
Spare Parts Fund	
All existing units to undergo overhaul	Not all, but done on priority basis

SUPPORT TO INSTITUTIONAL DEVELOPMENT 1992/93

ACTIVITIES ENVISAGED IN PROGRAM DOCUMENT 1992-12-05		ACTIVITIES ACTUALLY CARRIED OUT
Program Document ready	DEC	Assist Development of Program Document
	1993 JAN	
Discussion:Org.,job descript,policy,billing Courses: Business control & admin	FEB	
Instruction on O&M of power plants Commissioning of DG in Assab	MAR	Seminar:Business contr,procurem.,org&HR Planning installation of DG at Assab
Course: System planning, design &mgmt	APR	
Follow-up visit by Proj.mgr EEA Executives visit to Sweden	MAY	Tests of DG at Assab
SYDKRAFT Exec visit to Eritrea	JUN	Seminar in Distribution
	JUL	
	AUG	EEA Exec visit to Sweden
	SEP	Content & Priorities for new contract
	OCT	Participation in WB CEM
	NOV	
	DEC	
	1994	
ACTIVITIES ENVISAGED IN CONTRACT 1994-02-25	JAN	Pre-commissioning of DG at Assab
	FEB	
Commissioning of DG at Assab, no date Seminar in Supply Quality; Pers Safety	MAR	Final commissioning of DG at Assab
Visit Framework and Org Development	APR	
Option Communication Study	MAY	Seminar: policy; org/manual; job descript. Seminar: Business control and admin
2nd visit Supply Quality; Pers safety Option Tariff Study	JUN	Seminar: Supply Quality; Person. Safety Review of computer systems in EEA
Option Follow up Framework&Organisation	JUL	Review of telecom systems
	AUG	
	SEP	
	OCT	
	NOV	
	DEC	
	1995 JAN	Training in preventive maintenance of DG
	FEB	Seminars in Goals and Leadership

Recommended Tariffs (1995 prices)

ICS

		LRMC	1995	1996	1997	1998	1999	2000
Domestic								
	Energy rate - first 7 units	0.94	0.50	0.50	0.50	0.50	0.50	0.50
	Energy rate - all other units	0.94	0.80	0.89	0.94	0.94	0.94	0.94
	Standing charge	6	6	6	6	6	6	6
General								
	Energy rate	0.76	0.76	0.76	0.76	0.76	0.76	0.76
	Standing charge	6	6	6	6	6	6	6
Street lighting								
	Energy rate	0.99	0.79	0.89	0.99	0.99	0.99	0.99
	Standing charge	6	6	6	6	6	6	6
Industrial (LV)								
	Energy rate (single rate meter)	0.68	0.68	0.68	0.68	0.68	0.68	0.68
	Peak energy rate (2-rate meter)	2.88	2.88	2.88	2.88	2.88	2.88	2.88
	Off-peak energy rate (2-rate meter)	0.26	0.26	0.26	0.26	0.26	0.26	0.26
	Standing charge	18	18	18	18	18	18	18
Industrial (MV)								
	Energy rate (single rate meter)	0.58	0.58	0.58	0.58	0.58	0.58	0.58
	Energy rate - peak	2.14	2.14	2.14	2.14	2.14	2.14	2.14
	Energy rate - off-peak	0.24	0.24	0.24	0.24	0.24	0.24	0.24
	Standing charge	60	60	60	60	60	60	60
Industrial (HV)								
	Energy rate (single rate meter)	0.54	0.54	0.54	0.54	0.54	0.54	0.54
	Energy rate - peak	1.93	1.93	1.93	1.93	1.93	1.93	1.93
	Energy rate - off-peak	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	Standing charge	60	60	60	60	60	60	60

SCS

		LRMC	1995	1996	1997	1998	1999	2000
Domestic								
	Energy rate - first 7 units	1.52	0.50	0.50	0.50	0.50	0.50	0.50
	Energy rate - all other units	1.52	0.82	0.94	1.06	1.22	1.37	1.52
	Standing charge	6	6	6	6	6	6	6
General								
	Energy rate	1.30	0.91	1.04	1.17	1.30	1.30	1.30
	Standing charge	6	6	6	6	6	6	7
Industrial (LV)								
	Energy rate (single rate meter)	1.17	1.08	1.17	1.17	1.17	1.17	1.17
	Peak energy rate (2-rate meter)	3.67	3.38	3.67	3.67	3.67	3.67	3.67
	Off-peak energy rate (2-rate meter)	0.62	0.57	0.62	0.62	0.62	0.62	0.62
	Standing charge	18	18	18	18	18	18	18

Assab

		LRMC	1995	1996	1997	1998	1999	2000
Domestic								
	Energy rate - first 7 units	1.09	0.50	0.50	0.50	0.50	0.50	0.50
	Energy rate - all other units	1.09	0.62	0.70	0.81	0.92	1.02	1.09
	Standing charge	6	6	6	6	6	6	6
General								
	Energy rate	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	Standing charge	6	6	6	6	6	6	6
Industrial (LV)								
	Energy rate (single rate meter)	0.78	0.78	0.78	0.78	0.78	0.78	0.78
	Peak energy rate (2-rate meter)	2.94	2.94	2.94	2.94	2.94	2.94	2.94
	Off-peak energy rate (2-rate meter)	0.31	0.31	0.31	0.31	0.31	0.31	0.31
	Standing charge	18	18	18	18	18	18	18
Industrial (MV)								
	Energy rate (single rate meter)	0.64	0.64	0.64	0.64	0.64	0.64	0.64
	Energy rate - peak	2.02	2.02	2.02	2.02	2.02	2.02	2.02
	Energy rate - off-peak	0.29	0.29	0.29	0.29	0.29	0.29	0.29
	Standing charge	60	60	60	60	60	60	60

Figure 4.1
Weekday Energy Allocations ICS - 1996

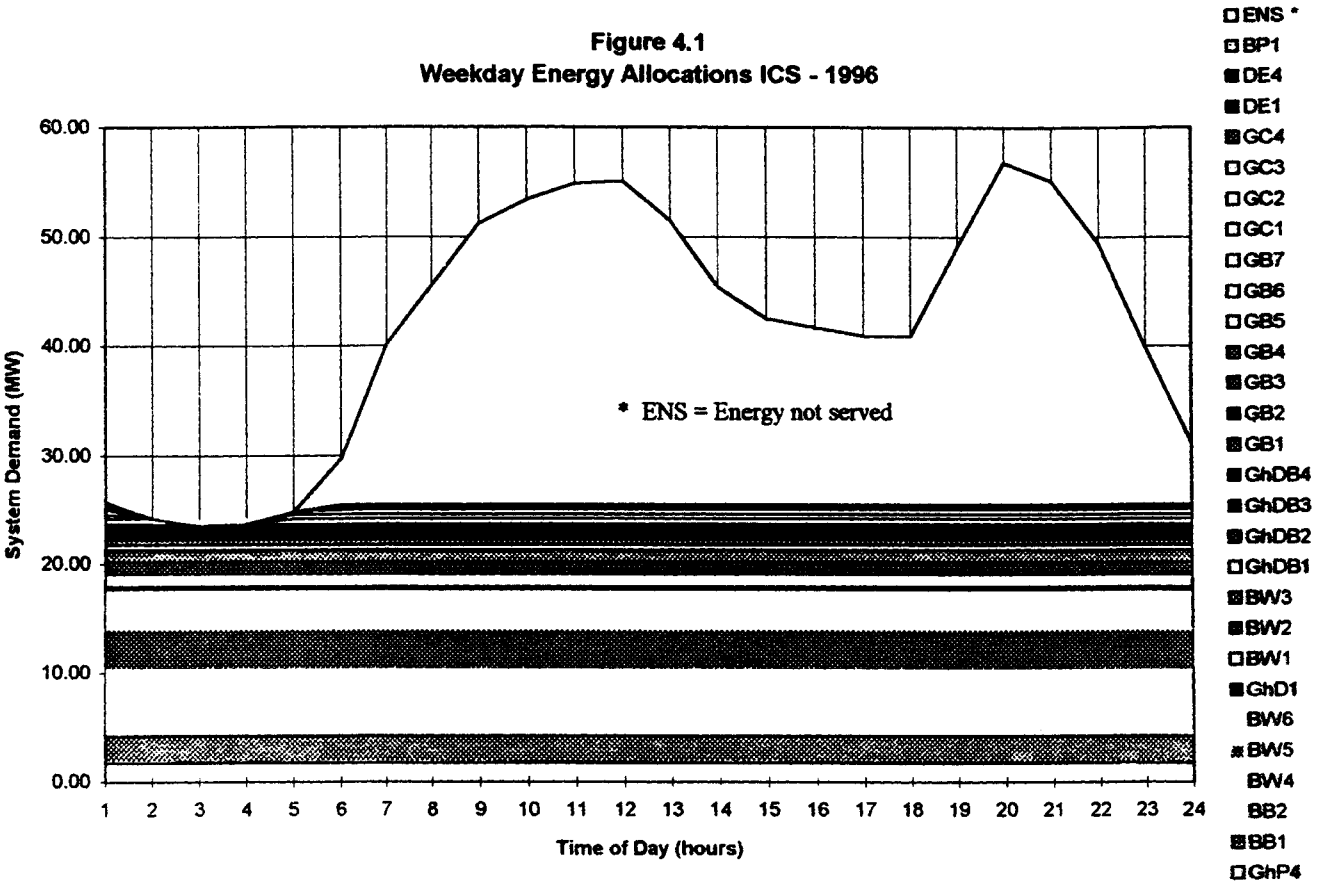
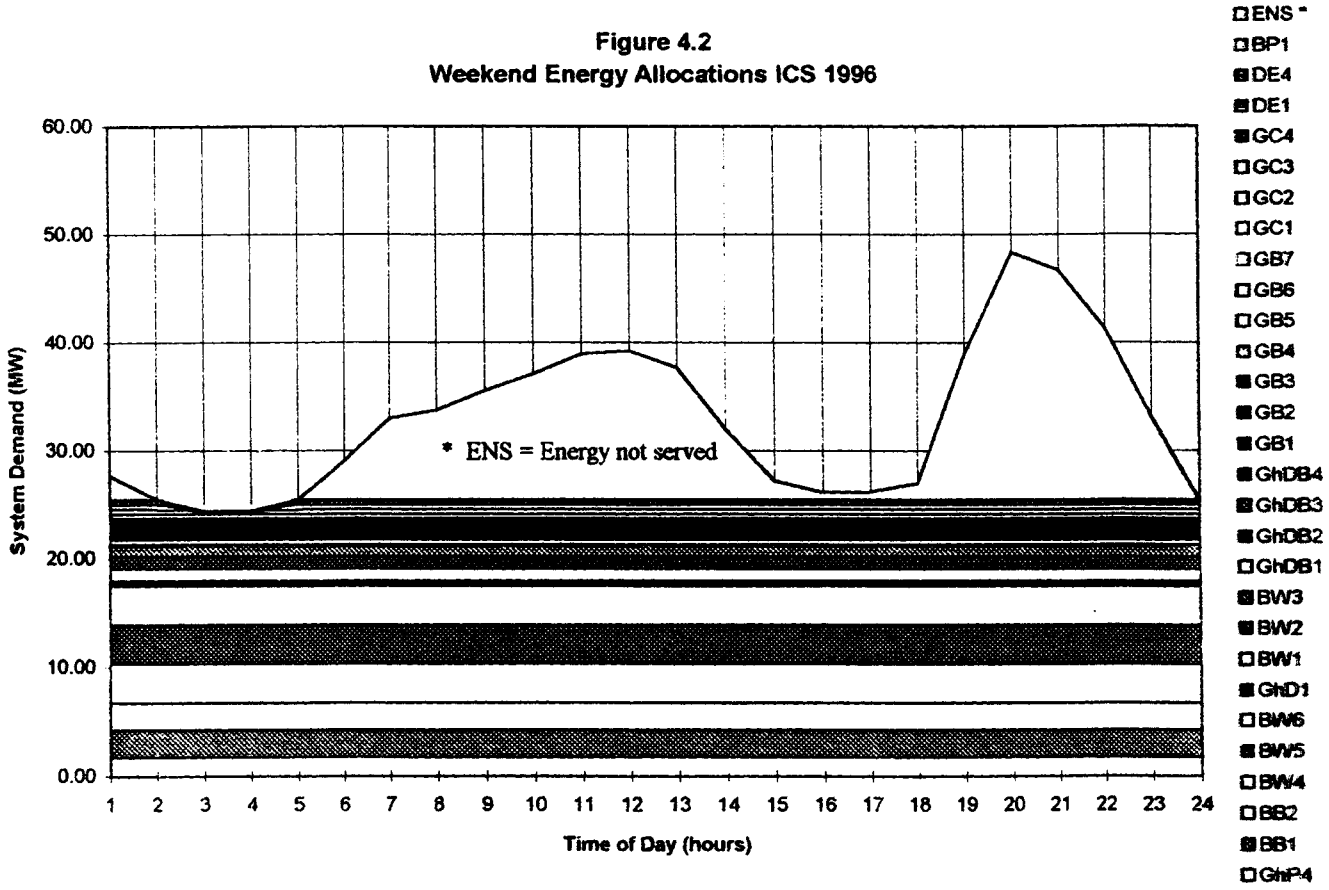
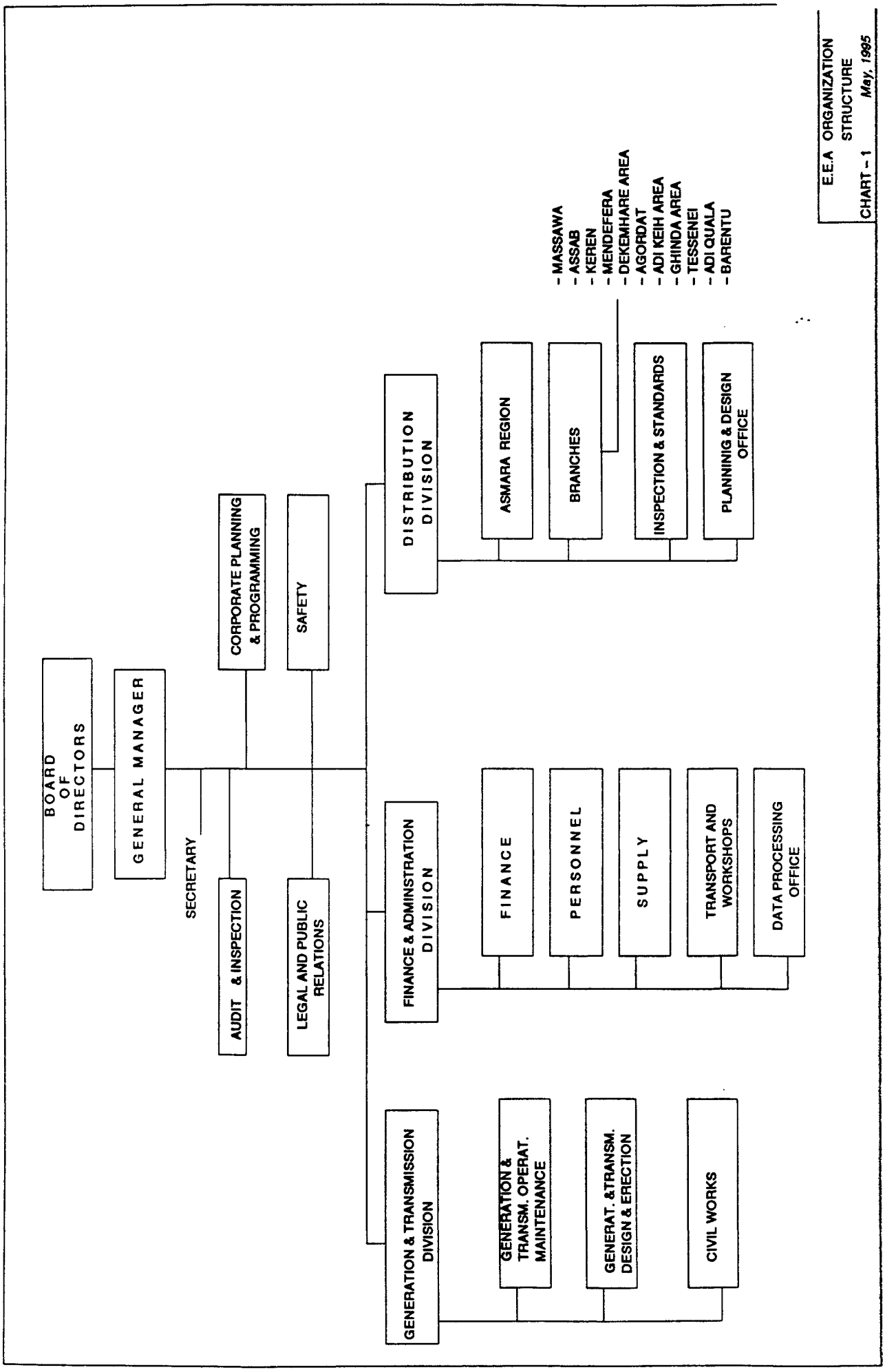


Figure 4.2
Weekend Energy Allocations ICS 1996

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SECRETARY
CORPORATE PLANNING & PROGRAMMING
AUDIT & INSPECTION
SAFETY
LEGAL AND PUBLIC RELATIONS
DISTRIBUTION DIVISION
ASMARA REGION
BRANCHES
- MASSAWA
- ASSAB
- KEREN
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- AGORDAT
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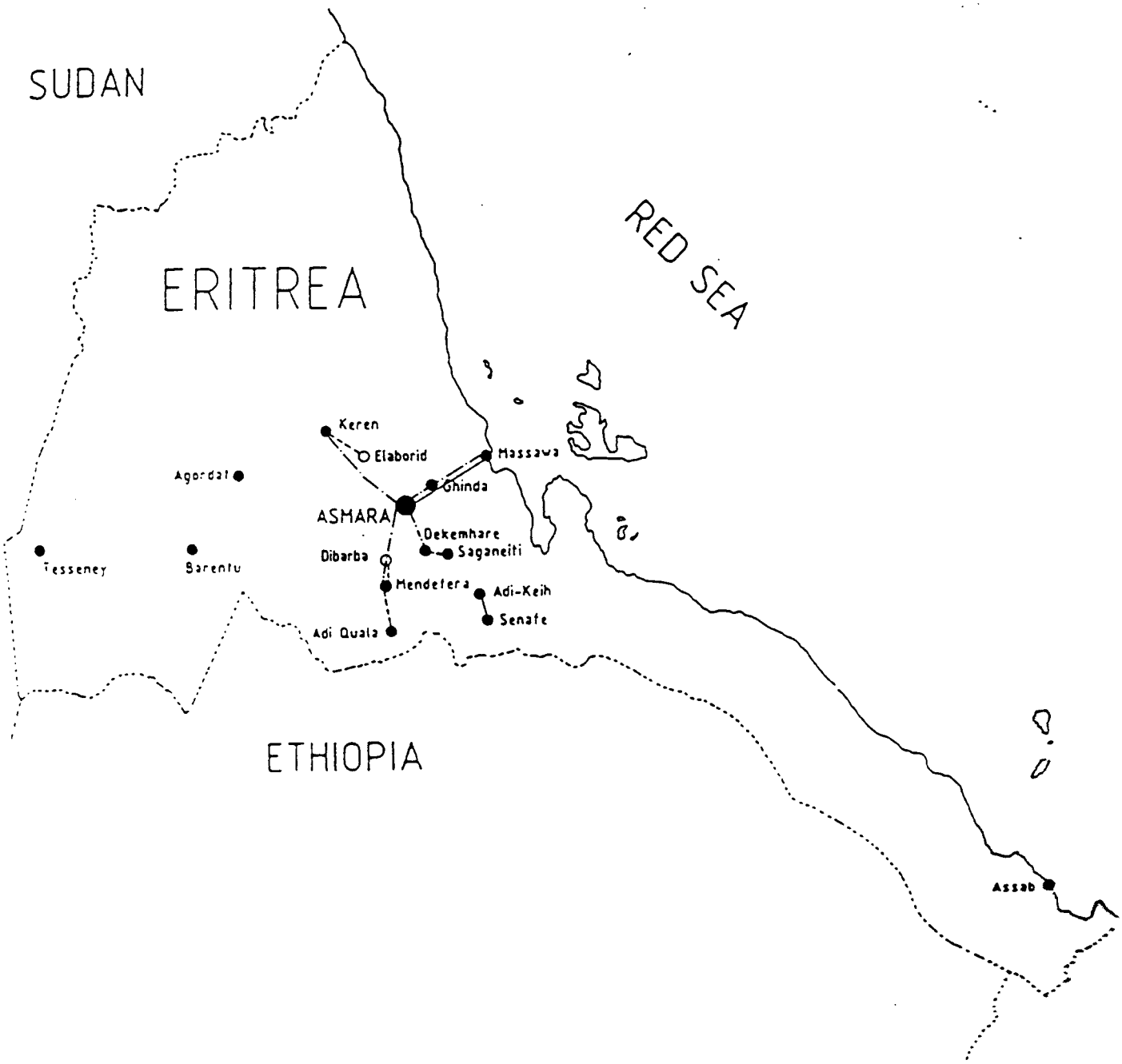
CHART - 1
May, 1995

MAP OF ERITREA



LEGEND

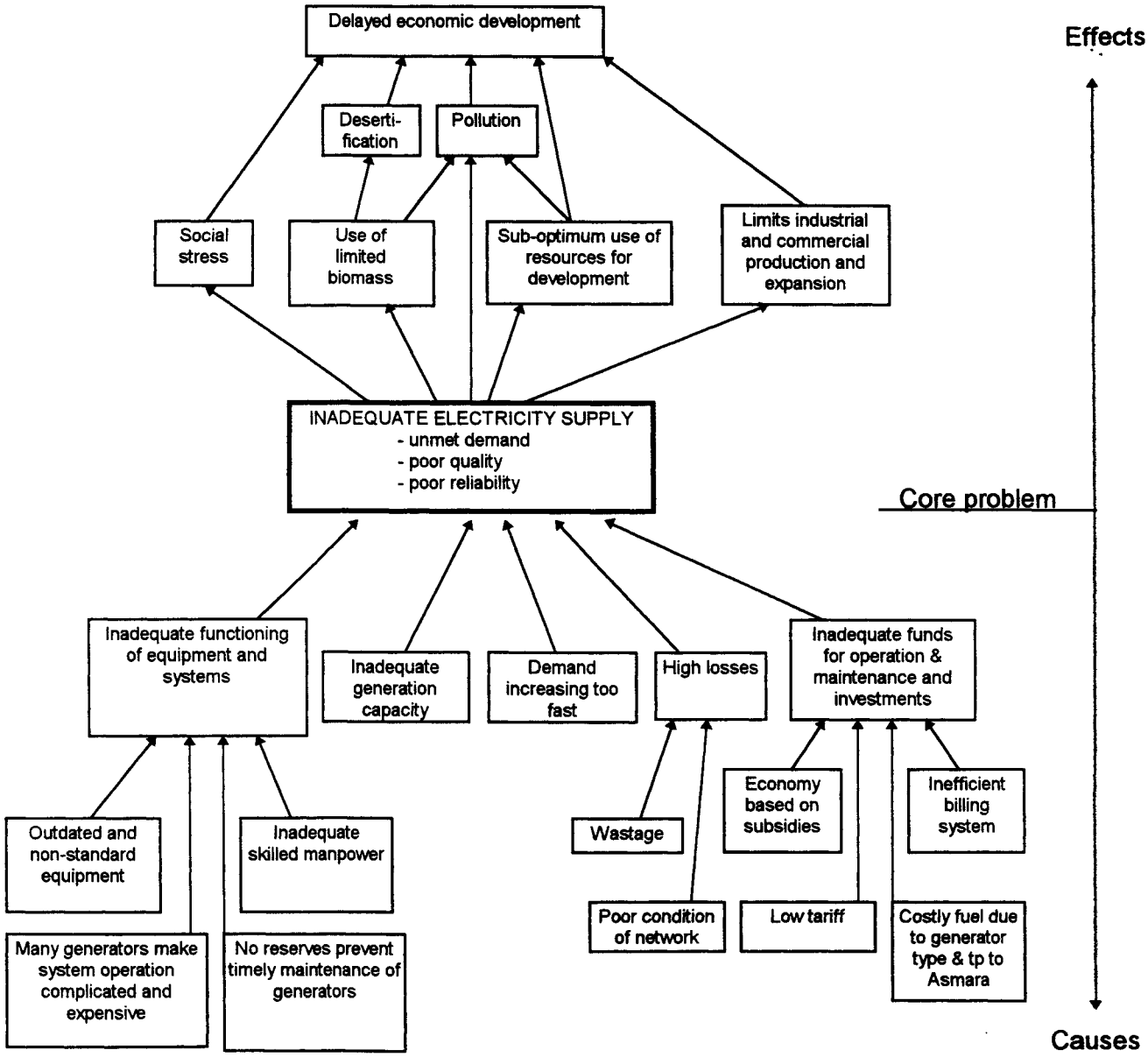
—·—·— PLANNED FOR 1997 (132kV AND 66kV)

– – – – PLANNED FOR 1995 (15kV)

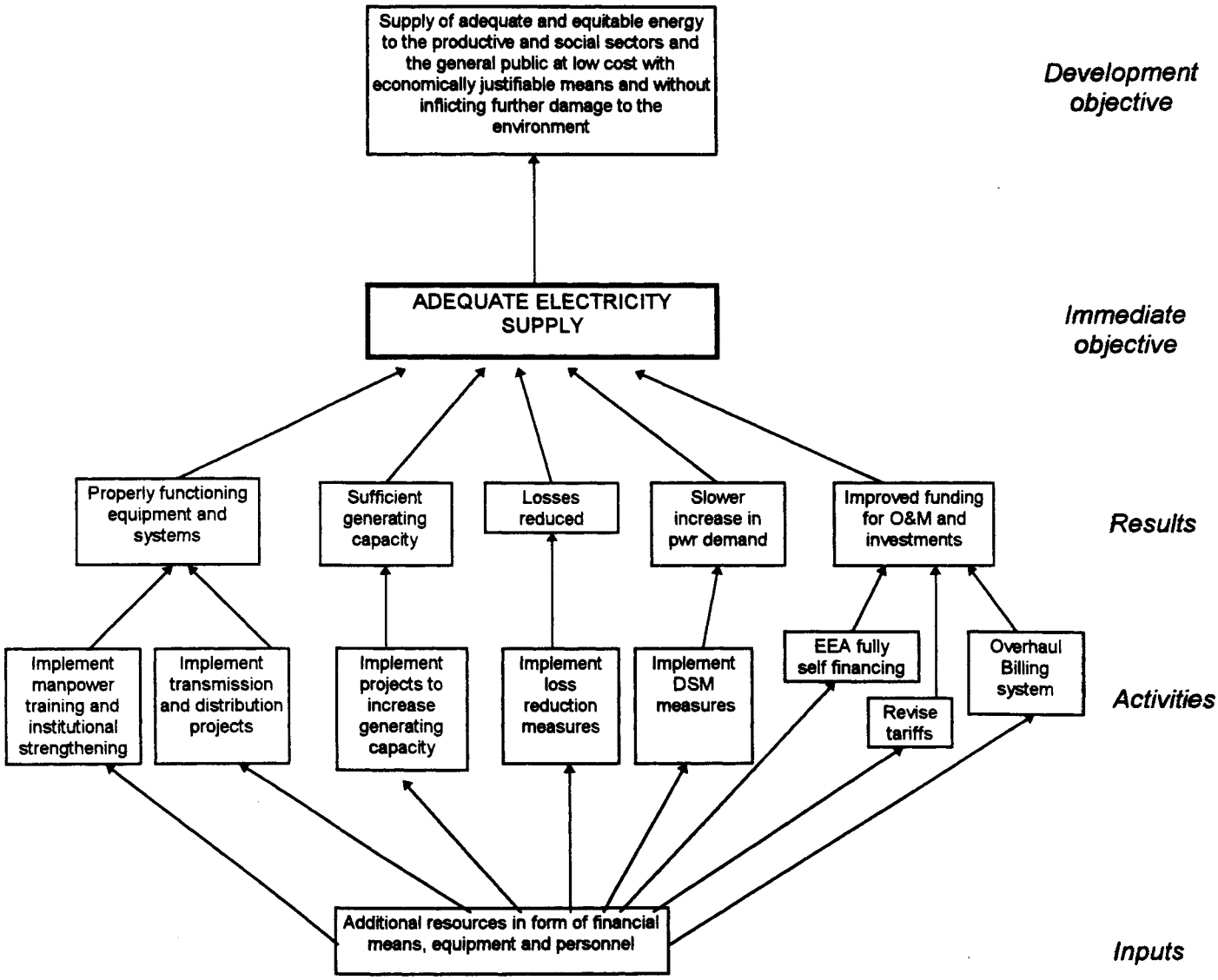
——— EXISTING

O NOT SUPPLIED AT MOMENT

PROBLEM TREE - ERITREA ELECTRICITY NETWORK



OBJECTIVE TREE - ERITREA ELECTRICITY NETWORK



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